The Effect of a Workplace Intervention Designed to Interrupt Prolonged Occupational Sitting on the Health of Desk-based Employees

Casey Peter Mainsbridge

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University of Tasmania

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Certificate of Original Authorship

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

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Signature:

Casey Peter Mainsbridge

Date: 1st April 2016

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Signature:

Casey Peter Mainsbridge

Date: 1st April 2016

Statement of Ethical Conduct

The research associated with this thesis abides by the international and Australian codes on human and animal experimentation, the guidelines by the Australian Government's Office of the Gene Technology Regulator and the rulings of the Safety, Ethics and Institutional Biosafety Committees of the University.

Signature:

Casey Peter Mainsbridge

Date: 1st April 2016

Abstract

Increasingly, environments such as the workplace have evolved into settings where prolonged sitting has become ubiquitous, most commonly among desk-based employees. The proliferation of sitting behaviour in the workplace can be attributed to a confluence of factors such as easy access to personal desktop computers, printers, and photocopiers; comfortable office chairs; and shared open plan office spaces that restrict opportunities to perform alternate behaviour to sitting. Effortless access and the convenience of technology has engineered movement out of the workday for many employees and workplaces.

Health research has identified a number of adverse effects associated with prolonged sitting such as increased risk of cardiovascular disease, increased all-cause mortality, and increases in indicators of metabolic syndrome; independent of adherence to recommended physical activity guidelines. Despite these negative associations, there is little evidence that workplace interventions have effectively addressed reducing sitting behaviour, or targeted the reduction of sitting as a primary outcome. To address these gaps, the effectiveness of a workplace intervention designed to interrupt sitting and increase short bouts of movement periodically throughout the workday was investigated in this thesis. The intervention depicted in this thesis is an interactive computer-based software program installed on the desktop computers of desk-based employees, predicated on a social ecological model that features a passive prompt to stimulate behaviour change by interrupting sitting at 45-minute intervals.

To test the effectiveness of the intervention on the health of desk-based employees, two sets of participants were examined in separate studies. In the first study the influence of the intervention on participants' health was investigated by measuring self-reported energy expenditure and a battery of physiological biomarkers in an

experimental group and a control group over a 13-week period. The participants were randomly assigned with replacement to either the experimental group who received the intervention (*n* = 20; *mean age* = 41.50 +/-12.39) or to the control group who did not (*n* = 26; *mean age* = 44.88 +/-9.65), and were full-time employees who worked eight-hour daily shifts and primarily had desk-based job responsibilities. Findings indicated that the intervention was effective in interrupting prolonged sitting and increasing short bouts of movement during the workday. This resulted in a significant increase in energy expenditure and a significant decrease in mean arterial pressure. There were no significant effects on the blood glucose, cholesterol, or triglyceride dependent variables.

The second study built upon the objective measures of the first study by testing participant perceptions of health behaviour change in the workplace, and if this change was sustainable. The participants (*N* = 43; *mean age* = 43.81 +/-9.94) were full-time employees who worked eight-hour daily shifts and primarily had desk-based job responsibilities. Participant perceptions of health and compliance to the intervention were collected over 26 weeks across three repeated measures: pre-test, post-test, and retention test. To measure the sustainability of perceptions of health behaviour change in the workplace, the passive prompting feature of the intervention was removed between the POS test and the retention test. In addition to supplement these measures of health, qualitative semi-structured interview data were collected throughout the experimental period.

Once the passive prompt was removed adherence to the intervention was significantly reduced. Despite this, participants' perceptions of improved health, which increased significantly when the intervention prompted them passively, remained high once the prompt was removed. This was further substantiated by the interview data, which indicated that employees were more likely to adhere to the program if they were

continuously prompted to do so. This suggests that passively interrupting prolonged periods of sitting and increasing movement throughout the workday is efficacious in improving several outcomes associated with health; but if sustainable change in sitting behaviour in desk-based employees is to occur a passive stimulus is necessary.

Statement of Co-Authorship

The following people contributed to the publication of work undertaken as part of this thesis:

Casey Mainsbridge, University of Tasmania.

Dean Cooley, University of Tasmania.

Scott Pedersen, University of Tasmania.

Sharon Fraser, University of Tasmania.

Author details and their roles:

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Located in chapter 3.

Candidate was the primary author (60% equivalent), responsible for the preparation of the article content, formalisation, development, and refinement towards publication. Authors two and four contributed equally to the development of the analysis and discussion (30% equivalent), and author three contributed to final preparation and editing (10% equivalent).

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Candidate contributed to the literature review, discussion, and minor editing (20%), with author one (50% equivalent) and author two (30% equivalent), contributing to the substantive development of the article, the underlying theme, formalisation, and development towards publication.

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Candidate contributed to data collection and collation, literature review, and discussion (20%), with author one (50% equivalent) and author two (30% equivalent) contributing to the substantive development of the article, the underlying theme, formalisation, and development towards publication.

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Candidate was the primary author (80% equivalent) responsible for the preparation of the article content, formalisation, development, and refinement towards publication. Authors two, three, and four contributed equipment to the formalisation and editing of the article (20% equivalent).

We the undersigned agree with the above stated "proportion of work undertaken" for each of the above published (or submitted) peer-reviewed manuscripts contributing to this thesis:

Signed:

Dean Cooley

Supervisor

Faculty of Education, University of Tasmania

Signed:

Scott Pedersen

Supervisor

Faculty of Education, University of Tasmania

Signed:

Sharon Fraser

Supervisor

Faculty of Education, University of Tasmania

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Chapter 1

Introduction

In the twenty-first century people are presented with a number of different environments where sitting is the dominant behaviour. Sitting has become ubiquitous for people when at home, when travelling, at school, and in the workplace. Increasingly, in environments where sitting is encouraged or is the only option available for individuals and groups, sitting for prolonged periods is the resultant behaviour. Thorp et al. (2009) described prolonged sitting as an extended period of uninterrupted sitting equal to or greater than four hours. Prolonged sitting has become common behaviour and a habit for many people, often at the expense of active movement through activities such as play, and walking or cycling to work, reducing daily energy expenditure compared with that of the 1980s and 1990s (Dunstan et al., 2005; Owen, Leslie, Salmon, & Fotheringham 2000). Sukula (2011), referring to the sitting behaviours of modern society, commented that our ancestors and predecessors used to sit down to take a break; now people stand up for a break. Potential adverse health effects are related to a lack of movement and reduced energy expenditure through prolonged sitting, including deleterious associations with cardio-metabolic health (Katzmarzyk & Lee, 2012; Koster et al., 2012; Matthews et al., 2012; van der Ploeg et al., 2012).

In recent years the definition of sedentary behaviour and sitting has evolved in the attempt to provide a more accurate description and prescription of what the behaviour entails. In 2012 the Sedentary Behaviour Research Network described sedentary behaviour as any waking behaviour characterised by energy expenditure greater than or equal to 1.5 METs (metabolic equivalents) while in a sitting or reclining POSure. Research conducted by Dunstan et al. (2010) investigating the adverse health effects of television viewing found that adults who reported greater than four hours of television viewing when compared to less than two hours of television viewing had a 50 per cent increase in the risk of all-cause mortality, and nearly a two-fold greater risk of cardiovascular mortality. In a 2013 meta-analysis of daily sitting time and all-cause mortality, Chau et al. found that there was a five per cent increased risk of all-cause mortality for each one hour increment in sitting time among adults who sat for greater than seven hours per day. Similarly, in research conducted by Matthews et al. (2012) examining amount of time in sedentary behaviours and cause-specific mortality in adults, participants who reported watching greater than seven hours of television per day but who also achieved greater than seven hours of moderate-to-vigorous physical activity per week had a 50 per cent increased risk of death from all causes, and twice the risk of death from cardiovascular disease. These studies and the associated findings in conjunction with the Sedentary Behaviour Research Network definition indicate the broad range of evidence that has informed the negative relationship and adverse health effects characteristic of sitting behaviour.

Many workplaces have evolved into an environment where prolonged occupational sitting time (POS) has become customary, impacting most on those whose occupation is primarily desk-based (Levine, 2010; Thorp et al., 2012). Research has demonstrated that POS can impact negatively on cardio-metabolic risk factors such as blood glucose, cholesterol, triglycerides, cardiovascular disease, waist circumference, life expectancy and muscular activation (Dunstan et al., 2012; Hamilton, Hamilton, & Zderic, 2007; Healy et al., 2011; Katzmarzyk, Church, Craig, & Bouchard 2009; Owen, Sparling, Healy, Dunstan, & Matthews, 2010). This raises possible health concerns for all desk-based employees.

The health implications that are characteristic of POS have become prominent largely due to the advent of technology and electronic forms of communication which are prevalent in workplaces. These technologies have engineered movement out of the workday, forcing employees to spend over six hours per day in a seated position (Thorp et al., 2012). Consequently, over the period of a working life desk-based employees are increasingly vulnerable to the adverse health effects associated with POS.

To date, a typical approach to combat these adverse health effects has been a dose-response prescription of regular physical activity, namely 150 minutes of moderate-to-vigorous physical activity per week (Australian Department of Health, 2012). Despite the widespread health benefits associated with achieving 150 minutes of physical activity per week, contemporary research indicates that meeting this guideline may not be enough to counteract the health implications associated with POS (Owen et al., 2010). This is not to say that there are not health benefits in meeting the recommended physical activity guidelines, but a growing body of evidence suggests that prolonged sitting is not simply the absence of moderate-to-vigorous physical activity, but it is a distinct behaviour with unique environmental determinants that contribute to exclusive health consequences (Dunstan et al., 2010; Hamilton, Hamilton, & Zderic, 2007; Tremblay, Esliger, Copeland, Barnes, & Bassett 2007). Specifically, the biological, social, and environmental pathways that are affected by POS may differ from those which are impacted by physical activity. Based on these determinations, if the adverse health effects of POS persist independent of recommended amounts of physical activity, then more than voluntary physical activity is warranted to restrict them.

Sitting and moving behaviours of employees within the workplace are influenced by the interaction of multiple social and environmental factors. Bronfenbrenner (1992) proposed a theoretical framework known as the Social Ecological Model to provide possible explanations for behaviour and to identify particular social and environmental factors that influence health behaviour. Specifically, it postulated that health behaviour is influenced at different layers or levels of the environment that influence behaviour change. Health researchers have suggested that this model be applied to understand the determinants of sitting behaviour (Bennie, Timperio, Crawford, Dunstan, & Salmon, 2011; Owen et al., 2000; Sallis & Owen, 1997; 2002). Previous studies have utilised it to determine community connectivity and urban design and its impact on walking and cycling (Linenger, Chesson, & Nice, 1991; Saelens, Sallis, & Frank, 2003), obesity (Davison, Jurkowski, Li, Kranz, & Lawson, 2013; Leroux, Moore, & Dube, 2013), and population health change (Sallis, Floyd, Rodriguez, & Saelens, 2012; Sallis et al., 2006). Drawing from the theoretical approach used in these studies, this thesis examines the effect of a workplace intervention predicated on a social ecological model. By adopting this model to investigate POS, the physical and social environmental factors that determine workplace sitting behaviour can be articulated and potentially modified to improve employee health.

It is likely that the manner in which desk-based employees perform daily duties represents a routine or predictable pattern that is fostered by the physical and social workplace environment (Mummery, Schofield, Steele, Eakin, & Brown, 2005; Levine, 2010; Owen et al., 2010). A social ecological perspective asserts that the environmental cues that remain constant throughout the workday coerce employees to exhibit particular behaviours repetitiously, such as all work duties being completed on a computer while sitting at a workstation. Behaviours that are repeated frequently in a routine fashion, triggered by stable environmental cues, are described as habits (Aarts & Dijksterhuis, 2000; Ouellette & Wood, 1998). According to Aarts and Dijksterhuis a habit is a form of goal-directed automatic behaviour that is unconscious. Based on this, within this thesis the claim that both engaging in POS and accumulating POS are habits. It is argued that the dynamic interaction of individual, social, physical, and political elements of the workplace environment foster and support POST (Prolonged Occupational Sitting Time) to the extent that it becomes habitual. Furthermore, the contention that is an unwanted habit is made. Whether a habit is considered wanted, such as brushing teeth; or unwanted, such as tobacco smoking, it is often difficult to manipulate it or to create a new habit (Lally Van Jaarsveld, Potts, & Wardle, 2010; Ouellette & Wood, 1998). To improve employee health, incorporating a solution that interrupts prolonged periods of sitting and changes how employees interact with the workplace physical environment may reduce POS behaviour; this will be investigated in this research.

Workplace interventions to reduce POS and increase physical activity are scarce (Chau et al., 2010). To date, popular workplace health interventions have typically favoured dose-response, moderate-to-vigorous intensity daily physical activity, often with a ‘one size fits all’ approach based on one single bout of continuous physical activity (McGillivray, 2002; Thorp et al., 2012; Owen et al., 2010). In addition, many are grounded on voluntary user-activation. An example of this is the Global Corporate Challenge (Get the World Moving Limited, 2014) which is framed on participants voluntarily making the decision to perform movement. A limitation of such interventions is that participant engagement is infrequent (Blake, Mo, Malik, & Thomas, 2009; Blamey Mutrie, & Aitchison, 1995; A. Marshall, Bauman, Patch, Wilson, & Chen, 2002) and the chance of developing a habit through regular movement is lessened. Similarly, due to the irregularity in engagement by participants, interventions often fail to instigate sustainable behaviour change, and old habits remain (Aarts & Dijksterhuis, 2000; Ouellette & Wood, 1998). To reduce an unwanted habit such as POS and establish a habit that interrupts sitting behaviour with movement throughout the workday, voluntary activity alone may not be sufficient. Specifically, looking beyond a 30-minute bout of physical activity and targeting the hours when voluntary physical activity is not being performed may be an effective approach to creating a wanted habit.

Within the literature there is little evidence to suggest that workplace interventions have been designed to target health behaviour that is instigated involuntarily. Non-exercise activity thermogenesis (NEAT) refers to times when voluntary purposeful activity, sport, eating, and sleeping, are not being performed (Hamilton, Hamilton, & Zderic, 2007; Levine, 2004; Levine, Schleusner, & Jensen, 2000). Specifically, NEAT is the energy expenditure for the bulk of daily activities people undertake, and relates to the amount of heat energy produced from movement. Research has demonstrated that the energy expenditure associated with NEAT is highly variable, with sedentary individuals accumulating approximately 15 per cent and active individuals up to 50 per cent of daily energy expenditure through NEAT (Dauncey, 1990; Livingstone, Strain, Prentice et al., 1991; Ravussin, Lillioja et al., 1986). At present those who design and implement workplace interventions largely ignore NEAT as a focus for improving employee health in favour of incorporating a single continuous bout of physical activity during the workday. Considering that desk-based employees spend 75 per cent of their workday seated (Mork & Westgaard, 2007; Perry & Straker, 2013; Thorp et al., 2009; Toomingas, Forsman, Mathiassen, Heiden, & Nillson, 2012), their NEAT energy expenditure is very low. Workplace interventions that target NEAT and aim to reduce POS propose a shift in approach towards health behaviour change in the workplace. The present research will examine a workplace intervention that moves away from a traditional approach by passively prompting desk-based employees to engage in movement throughout the workday (Forster, 1982; Garrard, 2009).

A passive approach to behaviour removes the need to make a decision regarding whether or not to act; participation thus occurs involuntarily. Passive approaches to improve population health have included the enforced use of seat belts in vehicles, fluoride in tap water, and safety and protective gear at construction sites (Roberts, 1987). A major strength of passive approaches to improving health is that they operate on a communitarian model (Forster, 1982); they are based on common good: a communitarian approach to public health. Passive approaches prompt populations and individuals to accept that public health is a matter of community concern, and that public health problems are linked to social and economic problems (Rosen, 1974; Winslow, 1929). Specific to physical activity, one passive approach aimed at improving community health involves restricting central business districts primarily to bicycle and foot traffic, limiting road traffic and its associated environmental impact (Mansi, Mansi, Shaker, & Banks, 2009).

So far there is little evidence to suggest that passive approaches to improving employee health have been adopted in the workplace. Utilising a passive approach and prompting desk-based employees to change their health behaviour by reducing POS and increasing energy expenditure through NEAT is yet to be investigated. This thesis examines the effectiveness of an intervention, framed on communitarian principles, to engage desk-based employees in workplace health behaviour change through a passive approach.

In contrast to interventions that operate on a passive approach, popular methods adopted by researchers investigating workplace health interventions have been grounded on voluntary engagement and are typically underpinned by an active prompt (Conn, Hafdahl, Cooper, Brown, & Lusk, 2009; Dugdill, Brettle, Hulme, McCluskey, & Long, 2008) that functions on the premise that an individual decides to engage in the health behaviour, and decides how to perform the behaviour (Kahn et al., 2002). For example, an employee can choose to ignore the active prompt of a sign beside the elevator at a multi-storey workplace encouraging stair use. A limitation of an active prompt is that an individual can choose not to engage with the behaviour, and the probability of changing behaviour is decreased when this is an option (Russell, Dzewaltowski, & Ryan, 1999). Possible outcomes from interventions underpinned by an active prompt are that participation and engagement become inconsistent and infrequent, and the likelihood of incurring sustainable behaviour change decreases (Bartram, 2009). Against this background, it is proposed in this thesis that a workplace intervention that utilises a passive prompt will more effectively engage desk-based employees in reducing POS and increasing NEAT than a workplace intervention instigated by an active prompt. Extending from this, the author proposes that a workplace intervention that functions passively presents an efficacious approach to increasing workplace energy expenditure, improving perceptions of health, and creating sustainable behaviour change in desk-based employees.

Desk-based employees were the target population for this research for three reasons. First, a large percentage of the Australian population over eighteen years is employed in the workforce. The most recent data from the Australian Bureau of Statistics (2009) indicated that two thirds of the adult population were employed (population of 22 million people), with 83 per cent of those employed being in a full-time capacity. Second, evidence from the literature shows that the number of employees in the Australian workforce whose occupation is desk-based or sedentary in nature is increasing (Kirk & Rhodes, 2011; Straker & Mathiassen, 2009). Finally, evidence in the literature indicates that employees are increasingly spending more time at work in terms of hours during the week (Golden, 2011), and for many the number of years in employment is increasing (Australian Bureau of Statistics, 2013). Overall, this evidence illustrates that desk-based workers are primary candidates to be exposed to POS. To measure the effectiveness of a workplace intervention and to address gaps identified in the field, a mixed methods research design was utilised in this research. Specifically, quantitative objective measures, self-report measures, and a qualitative evaluation measure were employed to collect data to inform the evaluation of intervention effectiveness. A limitation of the majority of studies investigating health behaviour change to date is that data collection methods have relied upon one method, typically a self-report mechanism (Adams, Soumerai, Lomas, & Ross-Degnan, 1999; Chau et al., 2010). This research was undertaken using two studies, Study A and Study B. Study A addressed Research Question 1, and Study B addressed Research Question 2.

RQ$_1$ Can a workplace intervention designed to interrupt prolonged occupational sitting improve the health of desk-based employees?

RQ$_2$ Can a workplace intervention designed to interrupt prolonged occupational sitting instigate and maintain health behaviour change in desk-based employees?

The overarching aim of this thesis was to evaluate the effectiveness of a workplace intervention designed to interrupt POS and increase NEAT in desk-based employees. To fulfil this aim, Study A involved an experimental group who received a workplace intervention and were compared to a control group who did not receive the intervention. The intervention was designed to interrupt POS and increase NEAT in a cohort of desk-based employees during the workday. The primary aim of Study A was to examine the impact of the intervention on employee health over a 13-week period. To measure employee health a combination of a self-report inventory and multiple objective measures were completed prior to the experimental period and again at the conclusion. Health was operationally defined by three dependent variables which functioned as data collection methods. First, perceptions of workplace energy expenditure were self-reported by participants using the Occupational Physical Activity Questionnaire (OPAQ)

(Reis, Dubose, Ainsworth, Macera, & Yore, 2005). Second, blood pressure measurements were recorded to assess the impact of interrupting POS on this physiological biomarker. Specifically, systolic and diastolic blood pressure measurements were reported and from these mean arterial pressure (MAP) was calculated. MAP is the average pressure throughout one cardiac cycle (Meaney et al., 2000). Third, to explore the physiological impact of interrupting POS more comprehensively, the physiological biomarkers blood glucose, cholesterol, and triglycerides were measured. The independent variable was an interactive computer-based software program designed to prompt employees to interrupt long bouts of sitting by standing to engage in a brief bout of NEAT periodically during work hours.

Study B was designed to develop from the findings drawn from Study A, but more specifically to gain a greater understanding of the impact that the intervention had on desk-based employees' health in terms of initiating workplace behaviour change, and if any health behaviour change was sustainable. The study design involved an experimental group who completed the pre-test Short Form 36 self-report of health (Ware & Sherbourne, 1992) before being exposed to an intervention which featured a passive prompt for 13 consecutive weeks. A second 13 weeks involved participants continuing with access to the intervention; this access differed from the first 13-week period in that it was voluntary.

A mixed methods approach was applied for this study, which in conjunction with self-reported health included a self-reported frequency of participation with the intervention over 26 weeks, and a qualitative evaluation through semi-structured interviews. The purpose of the interviews was to establish participants' perceptions of the intervention, and to authenticate if engagement with the intervention influenced workplace social and ecological factors. Being a field-based study, an action research methodology was adopted, underpinned by a communitarian model (Forster, 1982) to provide a platform for the achievement of the workplace health goal of reducing POS by interrupting desk-based sitting and incorporating NEAT into the workday. As Study B was to gain insight into the effectiveness of a workplace intervention to change participants' POS behaviour, there was no control group.

The intervention utilised to measure the dependent variables identified in the research questions given above was predicated on a Social Ecological Model (Bronfenbrenner, 1992). Specifically, the intervention prompted desk-based employees to interact and engage with the physical workplace environment to improve their health, for example by using the office wall to perform standing push ups, the office chair for standing squats, or the office stairs for step ups. Common features of the workplace physical environment, such as small office spaces, chairs at the work station, or building stairs, are viewed as barriers to movement. The social ecological approach to the intervention functioned to modify such barriers into facilitators of NEAT, with the intention of improving employee health.

Several studies have investigated employee sedentary behaviour and activity throughout the workday, using objective measures such as accelerometers (Owen et al., 2010; Parry & Straker, 2013). Accelerometers are small, lightweight devices, usually worn on an elastic belt positioned on the hip or lower back, that measure the frequency and amplitude of the body segment to which they are attached, often integrating this information in movement 'counts' (Chen & Bassett, 2005). Despite the increased use of accelerometers for objective measures, issues in the use of accelerometry for the assessment of sitting behaviour relate to device initialisation, processing, and signal feature extraction, (Corder, Ekelund, Steele, Wareham, & Brage, 2008). Key limitations of accelerometers as a measure of sitting is that they assess intensity of movement and therefore are not always able to distinguish between postures such as sitting or lying, or standing still (Atkin et al., 2012, Jannsen, Twisk, Toussaint, van Mechelen, & Verhagen, 2013); upper body movement is not always detected as these devices are placed around the waist. Often expertise is required for processing, cleaning, and statistically analysing data (Castillo-Retamal & Hinckson, 2011). Despite the increasing popularity of objective measures to assess sedentary behaviour and physical activity, and associated energy expenditure, several studies have typically used subjective measures to assess these (Blair & Brodney, 1999; Bryant, Lucove, Evenson, & Marshall, 2007; Clark et al., 2011; S. Marshall & Ramirez, 2011). According to Castillo-Retamal and Hinckson (2011), subjective measures are the most common in gathering data about behaviours under study because more information can be collected, with surveys the most frequent tool used to determine sedentary behaviour and physical activity. In the workplace self-report techniques such as surveys do not disrupt work flow, permit access to large samples, require only short periods of time to complete (Mummery, Schofield, Steele, Eakin, & Brown, 2005), are cost effective, and have a relatively low participant burden (Atkin et al., 2012). Based on these qualities, and also because the participants in this study were geographically spread around the state of Tasmania, it was decided that workplace energy expenditure and perceptions of health would be measured using validated surveys.

In the review of literature, evidence that proposes that POS is a health problem is documented. This evidence leads into the separation of POS, physical inactivity, and physical activity, in terms of the distinctive effects that they have on physiological biomarkers such as blood pressure, blood glucose, cholesterol and triglycerides. The delineation of these behaviours and their divergent physiological effects suggests that unique approaches to combating the adverse health effects of POS need to differ from those of traditional approaches to physical inactivity. Following this, determinants of the workplace environment that contribute to POST being a catalyst for an undesirable routine are considered; with the argument made that POS is a habit. Previous approaches to changing the sitting behaviour of employees in the workplace are appraised, revealing that interventions to reduce POS are scant. Most are grounded on active prompts which necessitate voluntary participation, but little is known about the value of passive approaches in changing health behaviours. Examination of both active and passive approaches is undertaken, followed by a review of studies incorporating interruptions to sitting.

The structure of this thesis is framed on addressing Research Questions 1 and 2, and providing evidence to support or negate the research hypotheses for Study A and Study B respectively. Chapter 3 provides the background for Study A and presents the method, results, and discussion for this study, concluding with a rationale for Study B and the factors contributing to the focus of that study. Chapter 4 details the methodology for Study B and presents the method, results and discussion for this study. In Chapter 5, conclusions drawn from the findings yielded by Studies A and B are detailed, approaches to improving these studies made, and recommendations for future research in the field of workplace health outlined.

Chapter 2

Literature

The aim of this chapter is to present evidence to support my thesis that periodically interrupting POS with short bouts of NEAT throughout the workday is an effective mechanism to reduce health risks associated with POS behaviour. To establish the problem, the relationship between POS and chronic disease is contextualised. It is then argued that prolonged sitting should not be classified as physical inactivity because it has effects on human functioning that are different from not being physically active. Building on this, the confluence of factors which make desk-based workers the most vulnerable to the risk of POS are identified. Here the argument that POS is a habit is made, and present evidence is presented for the method used in this research to address the research questions. The literature reviewed in this Chapter aligns with the timeframe for when the studies in this thesis were designed, and when data was collected. Study A was designed in 2009 and Study B was designed in 2010, with data collection occurring throughout 2010 and 2011.

The term ‘sedentary behaviour’ is commonly used in the literature to describe activity of low energy expenditure, less than or equal to 1.5 metabolic equivalents (METs) (Chau et al., 2010; Dunstan et al., 2012; Pate, O’Neill, & Lobelo, 2008; Tremblay, Colley, Saunders, Healy, & Owen 2010; van der Ploeg et al., 2012). Jette, Sidney, and Blumchen (1990) defined a metabolic equivalent as the amount of oxygen consumed when sitting at rest, equal to 3.5 millilitres of oxygen, per kilogram of body weight, per minute (3.5 ml 0_2/kg/min). Sedentary behaviours (from the Latin *sedere*, ‘to sit’) are typical in contexts such as workplace sitting, television viewing, computer and game-console use (also referred to as screen-based entertainment), time spent in automobiles (Owen et al., 2010) and lying down (van der Ploeg et al., 2012). Research on sedentary behaviour and health increased following a review by Owen et al. (2000) addressing environmental determinants of physical activity and sedentary behaviour. Since their review, health researchers have asserted that sedentary behaviour results in little energy expenditure and is a risk factor to cardiometabolic health, independent of moderate to vigorous physical activity. The term ‘sitting time’ represents what sedentary behaviour primarily involves, and is the behaviour in which adults spend the majority of their waking hours (Dunstan et al., 2012; Katzmarzyk, 2010; Owen, 2012). High volumes of sitting time have been labelled ‘prolonged sitting’ (van der Ploeg et al., 2012), identified as an extended period of uninterrupted sitting equal to or greater than four hours (Thorp et al., 2009). Against this background, this thesis will refer to prolonged sitting as the most common form of sedentary behaviour. Specific to the workplace, Levine (2010) reported that between logging on and logging off, employees can remain nearly continuously in their chairs. There may be deleterious health effects associated with prolonged sitting at work (Hu, Li, Colditz, Willett, & Manson, 2003; Mummery et al., 2005). Based on this, prolonged sitting at work will be referred to as prolonged occupational sitting (POS), and prolonged occupational sitting time (POST) will refer to indicators of POS in this thesis.

There is a growing body of evidence to suggest that prolonged sitting is a health concern (van Uffelen et al., 2010). With advances in technological and social innovations occurring rapidly, daily movement has been sacrificed for sitting. These advances promote the proliferation of prolonged sitting, and the creation of physical environments that encourage sitting. The negative health implications of POS encompass increased risk of cardiovascular disease, increased all-cause mortality, limited skeletal muscle contractions, and increases in indicators of metabolic syndrome such as insulin resistance, unhealthy weight and dyslipidaemia (Hamilton, Hamilton, &

Zderic, 2007). Recent studies investigating the health implications of prolonged periods of sitting have concluded that the negative health effects associated with the behaviour persist in spite of recommended physical activity guidelines being met.

POS and Health

POS is a health problem. For the purpose of this thesis, POS is identified as a specific type of sedentary behaviour shaped by particular components of the physical and social environment. There is much evidence to suggest that POS is a modifiable risk factor for a number of adverse health conditions such as cardiovascular disease, metabolic syndrome, unhealthy weight, type 2 diabetes and musculoskeletal problems (Dunstan et al., 2012; Hamilton, Hamilton, & Zderic, 2007; Healy et al., 2011; Katzmarzyk et al., 2009; Owen, Bauman, & Brown, 2009; Owen et al., 2010; Saunders, Larouche, Colley, & Tremblay, 2012); thus, increasing regular participation in physical activity is a foundation for community and workplace interventions. The workplace presents an environment whereby sitting for prolonged periods is habitual (Pedersen, Cooley, & Mainsbridge, 2014); with elements of the workplace such as desks, computers, and electronic communication promoting prolonged sitting (Healy et al., 2012). This presents a possible health hazard for employees.

A possible reason for workplace employees being exposed to POS is the influence of environmental characteristics and cues that support sitting. These have led to an increase in the number of workplaces that foster an environment where employees spend most of their workday sitting (Evans et al., 2012; Pronk, Katz, Lowry, & Payfer, 2012; Thorp et al., 2009). Computers, desk-based printers, photocopiers and comfortable office-based chairs all reduce energy expenditure and support POST. Moreover, many organisations striving to be cost effective by reducing sick leave and achieving optimal productivity create a demand whereby office-based employees remain seated at their desk for the majority of the workday, as this is associated with the perception that work is being done (Levine, 2010). With increased reliance on technology and its relationship to organisational effectiveness, efficiency and productivity, employees are sitting their way to poor health. Not only are the physical elements of a workplace influential in enticing employees to sit, but often social, cultural, political and morale factors interplay to create habitual POST. Rather than promoting a healthy workplace environment that is productive and values employee health (Chau, 2009), the combination of these factors may in fact be making employees unhealthy and unproductive in their office chairs.

The earliest research on POS was reported by Ramazzini in 1700 in Italy, investigating diseases of workers. Ramazzini noted that sedentary tailors were not as healthy as active messengers. The first epidemiological study using occupational physical activity was conducted by Morris, Healy, Raffle, Roberts, and Parks (1953), who investigated coronary heart disease and physical activity at work by comparing the sedentary and active behaviours of bus conductors and bus drivers. The major finding was that bus conductors, who climbed approximately 600 stairs per day at work, had half as many heart attacks as bus drivers who spent 90 per cent of their workday sitting. The evidence provided in this early research indicated that individuals with active occupations are more likely to be healthier and less likely to suffer from disease than individuals in sedentary occupations.

Despite these early findings of the adverse health effects of POS, health researchers and professionals in the 1980s and 1990s concentrated on increasing physical activity by prescribing national guidelines (American College of Sports Medicine, 1991; Blair et al., 1989; Blair & Connelly, 1996; Morris, Pollard, Everitt, & Chave, 1980; Paffenbarger, Hyde, Wing, & Hsieh, 1986; Pate et al., 1995). A common belief held by many was that meeting recommended guidelines would counteract poor health indicators that occurred from being physically inactive; yet time spent sitting was not considered in this approach to improving health.

In 1999 Australian researchers conducted the Australian Diabetes, Obesity, and Lifestyle (AusDiab) study to examine associations between television viewing, physical activity, and the presence of metabolic syndrome. According to Kaur (2014), metabolic syndrome is a constellation of interconnected physiological, biochemical, clinical and metabolic factors that directly increase the risk of cardiovascular disease, type 2 diabetes, and all-cause mortality. In a representative sample of 11 247 adults aged over 35, AusDiab demonstrated that 25 per cent of men and 14 per cent of women had metabolic syndrome. Participants with metabolic syndrome spent more time watching television (Dunstan et al., 2005) and in addition were significantly less active than participants without metabolic syndrome. Specifically, more than 14 hours spent sitting and viewing television was positively associated with an increased risk of insulin resistance, unhealthy weight, and dyslipidaemia in both men and women. Conversely, the participants who performed regular weekly physical activity had reduced association with several components of metabolic syndrome. The researchers concluded that not only increasing participation in physical activity, but decreasing the amount of time spent sitting, are central to reducing the likelihood of metabolic syndrome.

The findings from the AusDiab study indicate that sitting behaviour appears to be a unique risk factor for cardio-metabolic disease, even after adjustment for moderate-to-vigorous physical activity. These findings created an awareness that prolonged periods of sitting may contribute negatively to health, and subsequently led to an increase in studies exploring the behaviour. Recent research has linked prolonged sitting to an increased risk of disease and increases in all-cause mortality (Katzmarzyk & Lee, 2012; Matthews et al., 2012; van der Ploeg et al., 2012). A study by Koster et al. (2012)

investigated the effect of objectively measured sitting behaviour on mortality and whether this association was independent of moderate-to-vigorous physical activity, in 1906 males and females aged 50 years and older. Results showed that mortality risk increased significantly with greater time spent sitting. Of the study cohort, those with the highest percentage of sitting time had over three times the risk of mortality compared to those with the lowest percentage of sitting time. This connection between sitting and mortality was independent of moderate-to-vigorous physical activity.

Although efforts throughout the past two decades have been directed at increasing physical activity levels in the workplace, there is limited evidence regarding recommended approaches for reducing sitting time (Chau et al., 2010). According to Dunstan et al. (2010) and Owen et al. (2010), the environments in which sitting occurs might be determinants of the behaviour. For example, in the workplace desk-based employees spend the majority of their workday seated. Individuals in desk-based occupations have little choice in the amount of sitting they do during the typical workday, or in the type of activities they perform. This is evidenced by the Stand Up Australia project (Thorp et al., 2009), which investigated the active and sitting behaviours of 131 office-based, call centre, and retail employees. Data were collected over a seven-day period (five workdays and two non-workdays) using accelerometers to detect time spent sitting. The project revealed that 77 per cent of time at work was spent in a seated position. If two thirds of the time spent at work is seated, then it is likely that environmental factors in the workplace encourage employees to sit, subsequently leading to POST. Hence, identifying the environmental factors that determine the occurrence of sitting behaviour (Duncan, Spence, & Mummery, 2005) is an approach towards modifying and potentially reducing POS.

During the course of their working life, desk-based workers spend an average of 80 000 hours sitting (Dunstan et al., 2010). A chief reason for this is that the physical and social environments typical in workplaces have engineered physical movement out of the workday (Giles-Corti & Donovan, 2002; Saelens, Sallis, & Frank, 2003; Sallis et al., 2006), resulting in large amounts of time spent sitting. Physical and social barriers are created which deter desk-based employees from moving while at work. Previous research has contended that a social ecological approach be utilised to understand the determinants of prolonged sitting behaviour and physical activity behaviour (Owen et al., 2000; Sallis and Owen, 1997, 2002). Such a model posits that multiple levels of influence; physical, social, psychological and political, combine to influence behaviour (Bauman, Sallis, Dzewaltowski, & Owen, 2002; Bronfenbrenner, 1992; Sallis et al., 2006; Spence and Lee, 2003). A social ecological framework acknowledges that individual, physical, social, and policy factors interact to promote or subdue participation in physical activity; therefore, it is conceivable that it could be used to recognise the characteristics of the workplace environment that contribute to POST.

Researchers have used a social ecological model as an overarching framework for understanding the dynamic interrelations among diverse personal and environmental factors related to health behaviour change (Schneider & Stokols, 2009). More specifically, in an attempt to promote workplace health behaviour some employers have used environment-focused interventions (e.g., employers challenging employees to use the stairs instead of the lift as a type of workplace competition) to improve the social acceptance of physical activity in the workplace (Quintiliani, Sattelmiar, & Sorensen, 2007).

Perhaps unknown to these employers, practical applications such as this utilise elements of Bronfenbrenner's (1992) ecological systems theory of human development, which depicts multiple 'layers' of the environment that influence behaviour change. These layers include the microsystem, mesosystem, exosystem, and macrosystem. Specifically applying these layers to the typical office-based workplace, the microsystem might include elements with which employees have direct contact with on a daily basis, such as their desk and their office colleagues. These elements have a direct influence in shaping behaviour, and in turn may be shaped by behaviour (Sallis & Owen, 1997). The next layer, referred to as the mesosystem, represents the connections between the various structures within an employee's microsystem. For example, all employees within a workplace may choose to take the lift to the third floor instead of using the stairs because peer pressure dictates this to be the preferred means of transport. The next social ecological layer within this theory is the exosystem, with which employees do not interact with directly but by which the microsystem may be manipulated; such as workplace policies that mandate the amount of time a call centre employee can be off the phone and away from the workstation. Finally, the macrosystem layer is composed of cultural values and norms common to all desk-based workplaces, such as early-career employees believing that they should not leave their desk in fear of the perception that they may be seen as unproductive and wasting company time. In interpreting Bronfenbrenner's theory it is important to note that these four layers are not mutually exclusive, but are intertwined in their contribution to workplace health behaviour change.

A social ecological model incorporates a wide range of influences on behaviour rather than positing that behaviour is influenced by a narrow range of psychosocial variables (McLeroy, Bibeau, Steckler, & Glanz, 1988; Stokols, 1996). In contrast, previous frameworks for physical activity research that specify psychosocial and social influences on behaviour have been dominated by the Health Belief Model (Rosenstock, 1974), Theory of Planned Behaviour (1991), Social Cognitive Theory (Bandura, 1997), and the Transtheoretical Model (Prochaska & DiClemente, 1983). Although these models have led to effective interventions (Dishman & Buckworth, 1996; Kahn et al., 2002), they focus almost exclusively on individuals or small groups, and possess additional limitations. For instance, recruitment rates to interventions which target individuals and small groups are typically modest (Sallis et al., 2006), and maintenance of physical activity following interventions is poor (McLeroy et al., 1988). Furthermore, effect sizes for many types of interventions based on the individual are small to moderate (Dishman & Buckworth, 1996). A social ecological model includes variables at multiple levels such as biological, psychological, interpersonal, cultural, organisational, policy-based rules and regulations (Sallis et al., 2006). Applying such a model in the workplace can indicate which environmental factors influence health behaviour, and combined with education can lead to the capacity to change social support mechanisms and cultural belief.

When analysing the environment it could be argued that the workplace is not designed for, nor has the capacity to encourage and promote, opportunities for employees to engage in physical movement. Previous research has acknowledged that the environments which people populate present barriers to engaging in physical activity (Frank, Engelke, & Schmid, 2003). For example, working in a desk-based job in a shared office space with several other employees and limited area poses several physical and social barriers to being active. A review of perceived environment and physical activity characteristics (Duncan, Spence, & Mummery, 2005) reported that identifying and modifying environments to produce positive changes in physical activity is important, and that favourable alterations to populations may produce changes. Targeting the barriers in the workplace which discourage movement, and arbitrarily modifying how employees engage with them, is one way of changing the culture of prolonged sitting and little movement. An example of this is desk-based employees who share a workstation standing from their chairs together and walking the stairs for three minutes every hour. By identifying barriers to physical movement in the workplace and implementing multilevel interventions that change how employees physically and socially engage, opportunities exist to increase NEAT movement. Thus, interventions in the workplace that are aimed at modifying how desk-based employees engage with their office chair and computer may be an avenue for imparting positive change and reducing POST.

A workplace intervention underpinned by a social ecological model (Bronfenbrenner, 1992) can incorporate elements of the physical environment and social environment, in combination with movement, to attract and maintain employee interest and adherence (Bennie et al., 2011). Interventions should try to influence as many of the layers that influence employees' health decisions as possible, to ensure success in changing their health habits. Identifying all the factors within the workplace environment that are influential in encouraging sitting behaviour should provide guidance in the development of intervention strategies that will transpose perceived barriers into movement opportunities, and thereby reduce POST. For example, employees in a shared office space might choose to have a walking meeting where instead of meeting around a conference table, they choose to walk around the building together while discussing work-related agenda items and strategic plans for corporate growth. Interpreting all of the influences within the workplace environment, and effectively addressing these, present opportunities to increase the effectiveness of workplace interventions.

Previous research has incorporated a social ecological framework to determine how physical and social environments influence the adoption of health behaviours. A study investigating transportation, urban design and planning domains found associations between physical environment variables and walking or cycling for transport (Saelens, Sallis, & Frank, 2003): residents of communities characterised by high street connectivity and highly walkable land area reported significantly more walking and cycling for transport than residents of poorly connected and low walkable land area. Similarly, a study at a naval base in the United States of America incorporating simple environmental changes such as building bicycle paths and supplying exercise equipment resulted in an increase in the use of bikes and exercise equipment over a one year period compared to a control community (Linenger, Chesson, & Nice, 1991). The increase in use of bikes and exercise equipment also led to improved cardio-respiratory fitness levels in the intervention group compared to the control group. These findings provide support for the impact of modifying environmental factors to change movement behaviour. It is reasonable to assume that by modifying the workplace through simple changes to behaviours that are repeatedly performed during the workday, such as sitting, barriers to movement may actually be embraced to actually enable movement within the workplace.

Currently less is known about what factors are influential in workplace environments that encourage POST, and thus reduce workplace movement. To examine the social ecological correlates associated with self-reported short physical activity breaks in desk-based employees, Bennie et al. (2011) surveyed 801 desk-based employees from 316 workplaces in Melbourne, Australia. Participants (66 per cent female) self-reported on the frequency of short physical activity breaks per typical work hour. Breaks per work hour were assessed with a categorical response range from one break per hour through to six or more breaks per hour. Participants reported their level of agreement with 14 statements about correlates of physical activity during work hours;

the statements were developed using constructs from the social ecological framework (Sallis & Owen, 1997). To test the reliability of the survey items, a sub-sample of participants (*n* = 96) completed the survey on two occasions a minimum of 14 days apart. The participants were aged 54 years or younger.

Results from the Bennie et al. (2011) study indicated that on average desk-based participants reported taking approximately two and a half short physical activity breaks per hour per week. Unsurprisingly, participants who met recommended physical activity guidelines in their leisure and transport time reported taking more breaks than those who did not meet the guidelines. Participants self-reported that perceptions of lack of time and not having enough information regarding physical activity breaks were inversely associated with frequency of breaks. Considering that a perceived lack of time is a modifiable factor, restructuring the workday to enable regular short breaks from POS is a practical approach. Advice and guidelines regarding the duration and frequency of short breaks per hour while at work can be provided by print or electronically, acting as a reminder to break POS throughout the day. Bennie et al. (2011) suggested that strategies such as providing desk-based employees with regular cues to interrupt sitting time could be incorporated into workplace environments. Developing a reminder or prompt that functions regularly throughout the day could remove the perception that there is a lack of time to interrupt sitting and be active.

A social ecological framework has previously been implemented as an approach to promote physical activity and achieve population health change (Sallis et al., 2006, 2012). Sallis et al. (2006) asserted that multilevel interventions based on ecological models and targeting individuals, physical environments, social environments, and policies must be applied to achieve population change. They advocated ‘active living’, a broad term that incorporates four active living domains: occupational activities, household activities, recreational activities, and active transportation. The social ecological model constructed by Sallis, Floyd, Rodriguez, and Saelens (2012) is framed on the view that physical activity is a critical mechanism by which built environments can affect chronic disease. As societal changes have reduced the need for movement, increases in prolonged sitting in each of the four active living domains have occurred. Specific to the workplace, social ecological factors that influence physical activity and sitting behaviour include building design, stair design, physical activity facilities and programs, transit access, and parking (Sallis et al., 2006). Employee engagement in physical activity or POST is shaped by social and cultural influences that exist in a workplace environment, so interventions that include individual education and motivation to change social attitudes and organisational norms can have widespread and sustainable effects (Sallis et al., 2012). Interventions that adopt a social ecological model which targets environmental barriers and facilitators to physical activity may have a positive effect on reducing POST.

In the past decade, research investigating the health effects of prolonged sitting in various environments indicated that metabolic health is compromised regardless of recommended physical activity guidelines being met (Healy et al., 2011; Katzmarzyk et al., 2009; Owen, 2012; Patel et al., 2010). An increasingly popular viewpoint proposes that too much sitting is distinct from too little physical activity (Healy et al., 2008; Hu, 2003; Owen, 2012). Such a viewpoint is framed on the distinct metabolic responses that occur during POS behaviour as opposed to those which occur when performing physical activity. The next section reviews literature on how POS effects metabolic health and how its effects differentiate from those obtained from physical activity.

Physical Activity, Physical Inactivity, and Sitting: Distinct Behaviours

The biological, social, and environmental pathways that contribute to POST might differ to those related to physical activity. The health effects associated with POS and physical activity may be products of different biological mechanisms (Katzmarzyk, 2010). This notion is supported by reports on excessive sitting (Dunstan et al., 2010; Tremblay, Esliger, Copeland, Barnes, & Bassett, 2007) which have contended that prolonged periods of sitting are not simply the absence of moderate-to-vigorous physical activity, but are a distinct set of behaviours with unique environmental determinants and a range of potentially unique health consequences. This perspective is supported by Owen et al. (2010), who acknowledged that although adherence to recommended physical activity guidelines has an established preventable role in multiple unfavourable health conditions, if individuals sit for prolonged periods their metabolic health is compromised. Popular workplace interventions predicated on a traditional ‘huff and puff’ 30-minute dose-response approach might not be sufficient to negate the adverse health effects associated with POS.

With the recognition that too much sitting is discrete from too little activity (Owen at al., 2010), greater attention may need to be paid to what people do in their non-exercise time. According to Hamilton et al. (2010), this non-exercise time often gets moved into the background, behind the widespread focus of the daily dose of physical activity; yet what actually happens in this time may be of equal importance to health. To illustrate this point, accelerometry data for two people with very different activity patterns were measured for a single day period during waking hours (Pate, O’Neill, & Lobelo, 2008). Participant One in the study did not participate in 30 minutes of moderate to vigorous physical activity, but did participate in light-intensity activity for 75 per cent of the time monitored (13 hour total monitoring period). Light-intensity activities include slow walking, fidgeting, and cooking. Participant One was sedentary for the remaining time (25 per cent). In contrast, Participant Two engaged in one hour of moderate-to-vigorous physical activity (4 per cent), meeting current physical activity recommendations, but spent 73 per cent of the monitored time sedentary and 23 per cent performing light-intensity activity. The daily behaviour of Participant One demonstrates that an individual may not meet recommended physical activity guidelines but this does not mean that they spend their day sitting. Similarly, an individual who meets or exceeds recommended physical activity guidelines might not spend the rest of the day being physically active.

Despite both participants spending substantial portions of the observed time engaged in sitting behaviour and light-intensity activity, their active behaviour and subsequent energy expenditure were noticeably different. Performing light-intensity activities increases metabolic rate, so undertaking this type of activity throughout the day can contribute significantly to overall daily energy expenditure (Pate et al., 2008). To clarify this, researchers estimated energy expenditure for Participant One and Participant Two using mean MET levels for each intensity category for sedentary (1.25 METs), light (2.2 METs), moderate (4.5 METs), and vigorous (7.5 METs) activity. The MET value for each category was multiplied by the number of hours spent in each activity intensity. Participant One accomplished an estimated 26.3 MET hours of activity during the monitoring period, despite not meeting recommended levels of moderate-to-vigorous activity. Participant Two accomplished an estimated 23.6 MET-hours, which incorporated an hour of structured moderate-to-vigorous physical activity. If the two participants were of equal body weight, then Participant Two expended less energy than Participant One, yet met the dose-response prescription of physical activity. This highlights not only the low energy expenditure associated with large amounts of time spent sitting, but points to the importance of considering the full range of energy expenditure rates identified in the activity range below that of moderate intensity.

Although the research provided by Pate et al. (2008) was observed for only a 13-hour period, the findings raise some points of interest regarding daily behaviour and energy expenditure. First, the impact of prolonged sitting parallels the lowest point of energy expenditure, with more time accumulated sitting leading to less energy expended. Second, moderate-to-vigorous physical activity is viewed as the primary method of increasing energy expenditure, yet if non-exercise time is predominantly devoted to sitting, then the debilitating effect of sitting on energy expenditure may be greater than the beneficial effect gained through physical activity. Third, reducing time spent sitting and increasing the amount of time in which individuals participate in light-intensity activity presents an effective means by which energy expenditure can be increased beyond that of moderate-to-vigorous physical activity. Finally, the value of an objective measure such as accelerometry used to capture data that accurately measure movement and non-movement is vital in determining how people move throughout the day. Thus, it appears, integrating light-intensity activities to interrupt prolonged periods of sitting offers the opportunity to increase daily energy expenditure, and in turn to mediate the deleterious health effects of POS.

Governments and health advocates have mandated 150 minutes of moderate-to-vigorous physical activity per week for health benefits, but this represents only one and a half per cent of a total week, or three hours of the time people spend awake (Katzmarzyk, 2010). Between one and five per cent of the waking day is spent in moderate-to-vigorous physical activity of any kind (Hagstromer et al., 2007; Troiano et al., 2008). To explore the relationship between sitting and meeting physical activity guidelines, Owen, Healy, Mathews, & Dunstan (2010) examined associations between television viewing time and continuous metabolic risk in men and women who reported at least 150 minutes of physical activity per week. They found that among the healthy, physically active adults, detrimental dose-response links to television time were observed with waist circumference, systolic blood pressure, and two-hour plasma glucose in both men and women, as well as fasting plasma glucose, triglycerides, and high-density lipoprotein (HDL) cholesterol in women only. This phenomenon, labelled the Active Couch Potato (Dunstan et al., 2010; Owen et al., 2010), is characterised by particular adverse metabolic consequences that prevail among those considered physically active. The emergence of this physical inactivity paradigm emphasises the function that all facets of movement can play in affecting health. Efforts to develop novel synchronised approaches to achieving more regular movement and diminish widespread exposure to sitting are needed to address this issue.

The term ‘non-exercise activity thermogenesis’ (NEAT) is commonly used when referring to the time when an individual is not performing voluntary physical activity (Hamilton, Hamilton, & Zderic, 2007; Levine, 2004; Levine, Vander Weg, Hill, & Klesges, 2006). Specifically, NEAT is the energy expenditure for all activities that do not involve sleeping, eating, or purposeful activity such as playing sport. It includes the energy expended standing, sitting, walking to work, working, typing, gardening, fidgeting, playing, shopping, and dancing (Levine 2004; Levine et al., 2006). The amount of NEAT that an individual produces reflects the type of physical activity executed and the thermogenic cost of each activity (heat energy associated with movement). According to Levine (2004), even in regular exercisers NEAT is the principal component of activity thermogenesis (process of heat production), and is the energy expenditure associated with all activities people undertake. NEAT is the most variable component of energy expenditure within and between individual lifestyles, ranging from approximately 15 per cent of total daily energy expenditure in very sedentary individuals to 50 per cent or more of total daily energy expenditure in highly active individuals (Dauncey, 1990; Livingstone et al., 1991; Ravussin et al, 1986). Considering the high amount of time that desk-based employees spend seated throughout the workday, identifying NEAT as a way to increase energy expenditure could reduce the adverse health effects associated with POS.

Recognising NEAT as a domain to target in the pursuit of improving population health is a new direction within the broad areas of physical activity and sitting behaviour (Levine et al., 2006). The development of this focus is framed upon an expanding knowledge-base of the unique physiological responses caused by POST, irrespective of the influence of the acute and chronic physiological benefits acquired from physical activity. It appears that interjecting periods of POS with short bouts of NEAT movement poses an opportunity to increase NEAT (Healy et al., 2008). If this method were to be introduced among desk-based employees, it is possible that the hazardous health effects associated with POS could be reduced. For instance, chewing is associated with deviations of energy expenditure of 20 per cent above that when at rest (Levine, Baukol, & Pavlidis, 1999). Very low levels of movement such as fidgeting can increase energy expenditure above resting levels by 20 to 40 per cent (Levine, Schleusner, & Jensen, 2000). Ambulation whereby body weight is supported and transported can substantially increase energy expenditure to twice the amount at rest, and purposeful walking at approximately four to five kilometres per hour can triple energy expenditure (Haymes & Byrnes, 1993). Presumably, if simple activities such as standing and moving for short periods can be incorporated into the workday of desk-based employees, energy expenditure will increase (Levine & Miller, 2007). Making this a routine part of the workday for desk-based employees may be just as important as meeting recommended physical activity guidelines to improve levels of health and reduce susceptibility to chronic conditions.

Hamilton, Hamilton, and Zderic (2007) reported on the role of low energy expenditure and sitting in the prevalence of obesity, metabolic syndrome, type 2 diabetes, and cardiovascular disease. They found that the most direct effect of prolonged sitting is the elimination of work normally performed by the large skeletal muscles when the body is upright. The absence of leg, back, and trunk movement throughout the workday are thought to have negative effects on the cellular processes in the skeletal muscles and tissues which regulate risk factors such as triglyceride and cholesterol accumulation (Hamilton, Hamilton, & Zderic, 2004; Zderic & Hamilton, 2006). The lack of muscle contractile activity that is experienced from prolonged sitting has a diminishing effect on protein lipoprotein lipase (LPL) activity, clearance of glucose from plasma triglycerides, and glucose-stimulated insulin secretion. Consequently, the lack of LPL and blood lipid activity impacts on the uptake of free fatty acids into skeletal muscle and adipose tissue. LPL is a protein that plays a major role in the metabolism and transport of lipids, and performs distinct physiological activities that regulate the supply of fatty acids to various tissues for storage or oxidation (Wang & Eckel, 2009). Prolonged periods of sitting lead to the forfeiture of the opportunity for collective energy expenditure which occurs from hundreds of recurrent muscular contractions involved in standing and moving.

Hamilton, Healy, Dunstan, Zderic, and Owen (2008) labelled the health impacts of prolonged sitting coupled with subsequent low energy expenditure of the behaviour as inactivity physiology. This notion is based on the tenet that the unique metabolic and clinical effects of prolonged sitting exist despite meeting physical activity guidelines. Specifically, the role of LPL and its regulation has served as the prototype for insights into how exercise and physical inactivity may affect disease outcomes (Hamilton,

Hamilton, & Zderic, 2007). At a physiological level, LPL is biologically processed and regulated differently depending on whether movement or sitting is involved (Hamilton, Hamilton, & Zderic, 2004; 2007). For example, the reduction in LPL activity in response to sitting behaviour is largely restricted to slow twitch oxidative muscle fibres, while increases in LPL activity in response to movement are found mainly in fast twitch glycolytic fibres. The relative decreases in LPL activity viewed in oxidative fibres following prolonged periods of sitting are more than four times greater than the increases observed in glycolytic fibres following intense exercise (Bey & Hamilton, 2003; Hamilton, Etienne, McClure, Pavey, and Holloway, 1998). This suggests that the responses of the different types of muscle fibre to sitting and movement behaviours, with the physiological mechanisms linking LPL activity to sitting, have a greater impact than those linked with physical activity.

Currently there is little known about the physiological impact of interrupting periods of prolonged sitting with light-intensity physical activity. To investigate this, Healy et al. (2011) measured how sitting time is accumulated and the metabolic health outcomes of interrupting sitting, using accelerometer-derived data from 4757 male and female ethnically diverse individuals aged 20 and over. The study sample was taken from the United States National Health and Nutrition Examination Survey (NHANES), and involved monitoring sitting time, light-intensity activity, moderate-to-vigorous activity, and the number and duration of breaks of participants. The cardio-metabolic outcomes measured were waist circumference, resting systolic and diastolic blood pressures, non-fasting serum measures of HDL-cholesterol, and non-fasting C-reactive protein concentrations. In addition, fasting measures were obtained for triglycerides, plasma glucose, and insulin in a sub-sample of participants (half of all sampled). The study reported that accelerometer wear time of the full sample was 14.6 hours per day, of which an average of 8.44 hours per day was spent sedentary, and 0.34 hours per day spent in moderate-vigorous physical activity. Independent of physical activity time and other potential confounders, total sitting time was detrimentally associated with several biomarkers, revealing significant detrimental linear associations of total sitting time with waist circumference, HDL cholesterol, C-reactive protein, triglycerides and insulin. A strong association with sitting time was observed for triglycerides and markers of insulin resistance, but not for blood pressure. In contrast to that of accumulating sitting behaviour, breaks were significantly beneficially associated with waist circumference, C-reactive protein and plasma glucose. Specifically, the study detected a relationship between sitting time and light-intensity time that was almost perfectly inverse. These findings highlight that moderating and interrupting sitting time may be of equal importance to regular participation in physical activity.

The study by Healy et al. (2011) adds to the growing body of literature that points to the hazardous health effects of prolonged sitting. To date, attempts to lessen the prevalence of prolonged sitting and its associated health effects have been framed on a dose-response prescription of weekly physical activity. Although the health benefits of regular activity are well reported (Haskell et al., 2007; Warburton, Nicol, & Bredin, 2006), reducing prolonged sitting by targeting the determinants of sitting behaviour has received only limited focus. The opportunity to make modifications to ecological elements of the workplace environment to promote and increase movement is an avenue worth exploring. How desk-based employees socialise and interact with the workplace environment may be a principal determinant of why those who fulfil desk-based occupations are vulnerable to sitting for prolonged periods in a habitual nature. Interventions that are predicated on a social ecological framework (Bronfenbrenner, 1992) offer the option to manipulate how employees engage with the workplace environment, and may change how employees adopt health behaviours. Adapting components of the physical and social environment to reduce the habitual behaviour of POST and encourage regular interruptions that feature short bouts of NEAT movement may create a health habit in the workplace. There is a need to establish a habit of standing from a seated position in place of simply spending the majority of each day in a chair (Blair, 2010).

POS as a Habit

Within modern day workplace environments many desk-based employees perform their occupations in a routine, habitual manner. Work-related tasks and duties are largely carried out from a desk-based chair while using a computer. Habitually, desk–based employees remain seated for the majority of the workday, which is typically framed around a 40-hour working week (Australian Institute of Family Studies, 2008). Repeated and consistent POS places desk-based employees at increased risk of a number of health conditions (Owen et al., 2010), which over time can develop into chronic health conditions if sitting behaviour does not change (Healy et al., 2012). The habitual nature of POS in combination with the associated adverse health risks indicate that desk-based sitting is a habit (Levine, 2010).

When explaining the behaviour of people on a daily basis, the notion of habits symbolise established methods of action. In essence, the majority of people’s actions are carried out on a customary basis, repeatedly displayed in matching physical and social surroundings. Habits are learned sequences of acts that have become automatic responses to specific cues, and are functional in obtaining certain goals or end-states (Hull, 1943; James, 1890; Tolman, 1932; Triandis, 1977, 1980; Watson, 1914). Examples of this are sitting down at the workstation upon immediate arrival at work, having a coffee at the same time every day, and parking the car in the same spot each day. James (1890) believed that people make as many actions as possible automatic and habitual, making them cognitively unconscious and allowing for greater conscious processing so that more can be learnt. Theories of the origins of habits stem from the early tenets of James and are framed around the view that past behaviours performed frequently directly influence future behaviours (Hull; Skinner; Watson): people perform behaviours, tasks, and skills as they have done them previously.

Theoretical perspectives to explain behaviour. Research related to explaining and predicting behaviour throughout the 1970s, 1980s, and 1990s focused on expectancy-value attitude-behaviour models, most commonly the Theory of Reasoned Action (Fishbein & Ajzen, 1975), the Health Belief Model (Janz & Becker, 1984), and the Theory of Planned Behaviour (Ajzen, 1991). Models such as these provide insight into the reason-based and deliberate nature of behaviour, although Aarts, Verplanken, and van Knippenberg (1998) have argued that they overlook the fact that various behaviours are executed on a daily, repetitive basis, and can become habitual over time. For example, a desk-based employee at work has the intention to complete work-related tasks effectively and efficiently. This may be their sole focus in relation to their occupation, yet the effectiveness and efficiency with which the employee performs may be influenced by habits. The intention may be influenced by habitual use of the internet, habitually drinking coffee at the same times every workday, and habitually staying seated at their desk for most of the day, possibly inhibiting alertness and task attention. This does not imply that behaviour is not formed by beliefs, attitudes, and intentions, but recognises that individual attitudes and intentions can be mediated by habitual behaviour.

To determine whether behaviour is executed by beliefs, attitudes and intentions, or by habit, is dependent on a variety of factors. Beliefs are assumptions, theories, explanations, conclusions, and states of mind which individuals choose as mechanisms to help make sense of experiences (Fieser, 2008). For example, an employee might believe that the elevator is the only option for travelling between floors at the workplace, and not even consider using the stairs. Attitudes consist of affective components that involve an individual's feelings, behavioural components that influence how the individual behaves, and a cognitive component that involves an individual's beliefs (McLeod, 2009). For instance, employees may be aware that they can use the stairs to move between floors at work, but they believe that the elevator is easier, faster, and requires less effort; hence, their attitude influences their behaviour, and they use the elevator. In domains where behaviour is not well learned it will be controlled by beliefs and attitudes: deliberate and conscious reasoning takes place and the behaviour is determined by intentions (Verplanken & Faes, 1999). For instance, if it is raining outside then an employee could consciously decide not to walk during the work break to avoid getting wet and cold. In contrast to the notion of behaviour being determined by beliefs, attitudes, and intentions, Aarts and Dijksterhuis (2000) postulated that the direct influence of past behaviour performed frequently on future behaviour is largely influenced by habit. This premise builds on the early work of Triandis (1977), who suggested that habit may provide an independent role in distinguishing behaviour from intention: when a behaviour has been frequently performed in the past, it increases in habit strength. An example of habitual behaviour might be that when it is raining an employee still goes for a walk during the work break, because that is what they do every workday.

To analyse the processes by which past behaviour can predict future behaviour and the processes of habit and intention in everyday life, Ouellette and Wood (1998) conducted a meta-analysis of existing research. Their hypothesis was that past behaviour should have an effect on future behaviour, particularly when people have ample opportunity to perform a behaviour in a stable context. They undertook computerised literature searches from 1974 to 1994, dissertation abstracts from 1867 to 1994, and psychological abstracts from 1920 to 1973. Articles were included if they used measures of past behaviour frequency to predict behavioural intention or subsequent behaviour, resulting in a total of 64 independent studies in the review. The major finding from the meta-analysis was that past behaviour is an important predictor of future behaviour ($r = .39$, $p < .001$) with a medium (0.39) effect size. Behaviours that were well practised and performed in stable contexts were more likely to be repeated because they could be performed quickly, relatively effortlessly, in parallel with other activities, and with minimal or sporadic attention. Ouellette and Wood noted that the performance of acts such as most types of exercise, seat belt use, alcohol and coffee consumption, class attendance and church attendance were common on a daily or weekly basis in a stable, predictable, supporting context. Their analysis also revealed that conscious deliberation and decision-making were required to initiate and execute novel behaviours and behaviours performed in unstable or changing contexts. According to Ouellette and Wood, when behaviour is a function of conscious decision-making and deliberation, intention directly predicts the performance of the behaviour, and the effects of past behaviour are likely to be mediated through conscious intentions.

The findings from Ouellette & Wood (1998) can be applied to the behaviour of POS. Sitting at work, often for long periods of time, is well practised and is undertaken in a stable context: that is, desk-based employees predominantly sit at their workstation throughout each workday, supported by an environment that is the same every day. Therefore the probability of POST being repeated in the workplace environment is great; a result of physical and social cues that foster such a habit. This is demonstrated by desk-based employees having immediate access to technology such as a computer, phone, printer, photocopier, and roller chair that together promote the behaviour of POS as the optimum posture to perform all work-related tasks. Desk-based sitting is a behaviour that can be executed quickly, with little effort, simultaneously with other activities such as typing on the computer or talking on the phone, and requires minimal attention; it literally occurs unconsciously. In light of the work of Triandis (1977), who stated that the more often a behaviour is performed in the past the stronger it becomes as habitual behaviour, POS represents a habit. Triandis' statement is supported by Aarts and Dijksterhuis (2000), who reported that past behaviour performed frequently influences future behaviour through the notion of habits. POS can therefore be described as a habit that dictates how desk-based employees spend the bulk of the workday.

Testing habits through cycling behaviour. To test key assumptions about habits and how they can influence behaviour, Aarts and Dijksterhuis (2000) examined cycling behaviour among Dutch college students. Their research consisted of three experiments to test the hypothesis that habits are mentally represented and can be activated automatically. The three studies aimed to examine response rates in cyclists when primed with travel goals, to compare habits with conscious planning related to cycling travel, and to examine any interaction between habit strength and goal activation in relation to travel mode. They also considered what factors were influential in the formation and maintenance of habitual behaviour. Aarts and Dijksterhuis believed that habits are formed as a result of goal-directed automatic behaviour, and can be represented as the links between goals and actions which are instrumental in obtaining the goal. The strength of the link between the goal and the actions taken to achieve it is dependent on repeated performance of the goal, and the relevant actions in the past. For instance, if a desk-based employee has the goal of completing a series of tasks by the end of the workday, predictably the necessary action for this to occur involves prolonged periods of sitting at the workstation. Aarts and Dijksterhuis reported that the more often the activation of a goal leads to the performance of the same action under the same circumstances, the stronger the habit. This indicates that the more time an employee spends sitting and working at their office-based desk, the greater the likelihood is that sitting will become a habit. Thus, a desk-based employee who is exposed daily to the same working conditions, performs the same tasks daily, and executes these tasks sitting at the workstation, is likely to develop a sitting habit.

The experiments conducted by Aarts and Dijksterhuis (2000) revealed that habits were activated on the instigation of a goal. In the first experiment the findings illustrated that when participants (N = 54) were provided with travel goals (primed), those who performed the behaviour of bicycling on a more frequent basis were able to respond more efficiently to a series of questions regarding their travel behaviour. This showed, that the more frequently one engages in a certain goal-directed behaviour within a similar context, the stronger the association becomes, and subsequently the easier it is to automatically produce the behaviour by stimulating the goal.

Within the workplace office environment a link between goals and actions is evident, with the co-activation of the desire to complete work tasks (goal) while sitting at the desk-based computer (action). However, there is an alternative way in which strong connections between goals and actions are established, and that is through the formation of implementation intentions (Gollwitzer, 1993, 1996). These intentions take the shape of ‘I will start walking when the weather gets warmer’. Within the workplace an employee might intend to spend less time sitting at a desk-based chair while at work, and might increase the chances of actually doing this by planning for the active behaviour to happen. Intentions such as these are strategically formed by individuals to support the commencement of goal-directed actions, especially when the occurrence of the action is delayed and alternative actions can interfere. An example of this might be an employee who plans to stand up from the desk every hour, but is delayed by the phone ringing or receiving an email, and responding to the call or email. The formation of the intention to stand up every hour does not translate into actual behaviour because of interfering factors.

In experiment two, Aarts and Dijksterhuis (2000) compared habits with conscious planning. They hypothesised that habits may be stimulated by implementation intentions but that habitual behaviour does not benefit from planning. Results demonstrated that habits are the result of frequent past behaviour, whereas links branching from implementation intentions result from conscious planning. Specifically, participants (N = 53) who used their bicycle for transportation regularly did not benefit from planning, supporting the idea that they already possessed strong associations between travel goals and transport behaviour. Relating this to the workplace environment, the alliance of goal and action is evident in the union between completing work-related tasks (goal) and sitting at a desk-based chair (action), commonly observed in desk-based employees. In this context it could be argued that the action of sitting at the desk stimulates a cause-and-effect relationship with the goal of completing work-related tasks. Over time, frequently exhibited POS develops into a habit where the behaviour becomes goal-driven and automatic. In addition, in many workplaces POST is encouraged by stable and consistent physical and social environments (Ouellette & Wood, 1998), with cues such as desk-based chairs and computers prompting sitting behaviour. Establishing a goal to reduce POS by interrupting the preferred behaviour and implementing the action of standing from the desk-based chair characterises a positive step towards changing sitting behaviour.

Experiment three aimed to examine an interaction between habit strength and goal activation (Aarts & Dijksterhuis, 2000), with results indicating that the automatic activation of a habitual response is conditional on the presence of a travel goal. ANOVA results revealed a significant interaction between goal activation and habit strength was significant [$F(1, 85) = 5.35$, $p < .03$], demonstrating that participants ($N = 89$) who used their bicycle for transportation more regularly habitually responded faster than participants who cycled less regularly when a travel goal was presented.

In spite of these findings it should be noted that there are a number of limitations related to the participant sample in the three experiments (Aarts & Dijksterhuis, 2000). First, the participants were all studying at Eindhoven University, representing a convenience sample. No demographic information regarding gender, age, socioeconomic status, physical activity, or university degree was reported. These factors could have influenced participants' responses in the sense of the amount of time available to use a bicycle, individual reliance on a bicycle as a form of transport, physical capacity to use a bicycle regularly, and perceptions of using a bicycle beyond daylight hours. There was no identification of whether or not the participants were permanent residents of Eindhoven, or whether they were originally from another geographical location and had moved for study purposes. This too could have had a bearing on the type of student who used a bike, and how often the bike was used for transport. Finally, the measurement of habitual behaviour was completed through the behaviour of bicycling. Although the conclusions from the study are insightful, they might not be applicable to behaviours other than bicycle use.

Many facets of people's lives are based on a daily, repetitive pattern: the routine adopted for getting prepared to go to work, the travel mode used to get to work, performing the job itself, lunch time routine, and travelling home from work are all conventionally parts of the day when people tend to function on habit. Similarly, eating a meal, exercising, watching television, getting dressed, and POS are all performed frequently in a habitual nature. Despite the promotion of regular physical activity as a habit is widely endorsed and encouraged through various mass media strategies, individuals' uptake adherence to habitual physical activity is low (Sisson & Katzmarzyk, 2008). Therefore, specific methods and interventions are needed to embed NEAT movement into daily lives so that it does become a habit, benefitting people's health. The workplace offers a prime setting for accessing populations who are accustomed to perform many duties in a routine, and instilling regular NEAT into the workday could increase the likelihood of such behaviour becoming a habit.

Formation of habits. There are several views of how habits are acquired. The questions of how habits form, and how long it takes to form them, are often asked by researchers. To better understand the process of habit formation in everyday life, and query the concept of how long it takes to form a habit, Lally et al. (2010) conducted a study to investigate the habit formation process. Their aim was to investigate the development of automaticity in university students (30 men, 66 women) who were asked to repeat a behaviour of their choice in response to a cue, in an everyday setting, and to complete a measure of automaticity on a daily basis. The study attempted to control context stability by asking participants to carry out the behaviour in the same situation each day.

At an initial meeting the participants were asked to choose a healthy eating, drinking, or exercise behaviour that they would like to make a habit. The behaviour had to be one that they did not already do, could be performed in response to a prominent daily event (cue), and had a cue that occurred every day and only once a day. Examples of the behaviours selected were 'eating a piece of fruit with lunch', 'drinking a bottle of water with lunch', and 'running for 15 minutes before dinner'. Participants were asked to carry out the behaviour every day for 84 days (12 weeks). They were also asked to log on to the study website every day and report whether they had performed the behaviour the previous day.

The majority of participants, automaticity increased steadily over the days of the study, supporting the assumption that repeating a behaviour in a consistent setting increases automaticity. The results demonstrated that on average it took 66 days to form a habit, with a range of 18 to 254 days recorded to form a habit among the 96 participants. Based on this finding, workplace interventions which are aimed at developing a new habit by changing a pre-existing habit may need to be implemented for a minimum period of 66 days. If POS is a habit for desk-based workers, then attempts to change sitting behaviour and create new healthy behaviours need to be implemented for a minimum of 13 weeks to ensure sustainable behaviour change.

An opposing view. Although there has been substantial support for the notion of habits and how they are prominent in the performance of behaviours in a variety of contexts (Hull, 1943; James, 1890; Tolman, 1932; Verplanken & Aarts, 1999; Watson, 1914), not all researchers believe they are influential in facilitating the adoption of regular healthy behaviours. A review by Maddux (1997) scrutinised the concept of habits and argued that there were two logical and philosophical problems with the consensus definition of the term. Underlying Maddux's clinical psychological view was the need to question what people are doing and why they are doing it, not to offer answers or solutions, recommend techniques, explain how to design better studies, or present a new and improved theory. Maddux believed that habit is a word psychologists often use without questioning its meaning. The first problem expressed by Maddux was that the definition of habit is incompatible with how theories have defined and employed the notion of habit. It is often referred to as a kind of behaviour that is automatic and unconscious, but theoretical perspectives employ habit as a cause of behaviour. Maddux argued that a habit cannot be both a behaviour and the cause of behaviour. His second problem was that very few behaviours of interest in the psychology of health, exercise, and sport are the kinds that can become habitual in a way that is consistent with the definition. Maddux questioned whether people should be expected to engage in such behaviours automatically, without awareness, and at some point to no longer be under volitional control.

The claims and problems highlighted by Maddux were grounded on an individual perspective of how to describe behaviour, and the purposes for which specific behaviours were performed. Maddux formed his viewpoint dissecting various behavioural theories and establishing their subjective ‘gaps’ or ‘weaknesses’ in relation to the execution of a behaviour. His subjective commentary was not based upon new research or the conclusions from a study, but on deconstructing definitions of habit and theoretical tenets.

The theoretical frameworks that have been adopted in the present study counter those made by Maddux. Although the idea that habit characterises different types of behaviours is agreeable, the author of this thesis does not concur that habit is the cause of behaviour. This research embraced the viewpoint that behaviour is triggered by environmental cues, including both ecological and social cues within a particular setting (Owen et al., 2000, 2014; Tremblay et al., 2011). An individual exposed to a stable and constant environment in a frequent, repetitive way exhibits behaviours that become increasingly automatic and partially unconscious; therefore they can be described as habitual (Aarts & Dijksterhuis, 2000; Aarts, Verplanken, & van Knippenberg, 1998;

Ouellette & Wood, 1998). Hence, the argument that the workplace environment fits this description is made.

My study partly negates the second problem identified by Maddux and proposes that situational behaviour is typified by the regularity of past behaviour and how this can influence future behaviour (Aarts, Verplanken, & van Knippenberg, 1998; Hull, 1943; Skinner, 1938; Watson, 1914). This perspective might be better understood by examining the concept of trying to change behaviour. For instance, a person who walks during their lunch break every day may be expected to continue that behaviour while they continue to work in the same environment. A person who does not walk during their lunch break and consistently eats at their work desk may also be expected to continue that behaviour while they continue to work in the same environment. Arguably, the behaviour of these two employees during their lunch break is habitual: one demonstrates a healthy habit, the other an unhealthy habit. Furthermore, what they eat while performing their habitual lunch time behaviour may also be determined by factors that result in habitual eating behaviour. The challenge does not necessarily lie in developing habitual behaviour, but in developing approaches that reinforce healthy habits and in creating an environment whereby unhealthy habits can be diminished.

Approaches intended to change numerous health behaviours in the past four decades have largely focused on expectancy–value attitude–behaviour models such as the Theory of Reasoned Action (Fishbein & Ajzen, 1975), the Health Belief Model (Janz & Becker, 1984), and the Theory of Planned Behaviour (Ajzen, 1991). Although such models provide understanding and explanation of behaviour, they do not account for the fact that various behaviours are executed on a daily, repetitive basis and may become habitual over time (Aarts, Verplanken, & van Knippenberg, 1998). Within the workplace, desk-based employees sit in a routine, habitual manner that through frequent repetition in a stable environment contributes to POST. Furthermore, for this habitual behaviour to be changed, how desk-based employees interact with the physical and social elements of the workplace environment need to be modified. To create sustainable POS behaviour change and establish a potential new habit, a period of 13 weeks is required (Lally et al., 2010).

Approaches to Changing Sitting Behaviour in the Workplace

During the past 20 years a multitude of workplace interventions have been implemented in a variety of workplaces to increase the physical activity levels of employees during the workday (Brown, Ryde, Gilson, Burton, & Brown; Chau, 2009; Healy et al., 2012). Despite the recognition of increases in POS and the absence of daily movement while at work, few interventions have been designed to reduce sitting (Chau et al., 2010). Accordingly, there is a need to establish interventions that decrease the amount of time spent sitting while at work as a primary outcome, particularly in those employees who are desk-based and regularly use a computer.

In response to the growing body of literature which suggests that sitting time is a public health concern (Katzmarzyk et al., 2009; Owen, Bauman, & Brown, 2009; Patel et al., 2010; van der Ploeg et al., 2012), Chau et al. (2010) systematically reviewed the effectiveness of workplace interventions to reduce sitting. The criteria for their review included any intervention study that aimed to increase energy expenditure by increasing physical activity or reducing sitting; was conducted in a workplace; and used a specific measure of sitting or activities equal to or less than one and a half (1.5) METs as a primary or secondary outcome. The search was conducted for the period from January 1980 until April 2009. Following identification and screening of articles, 338 full-text articles were considered for eligibility, of which six were included in the final qualitative synthesis. Three of these studies were randomised controlled trials (Aittasalo, Miilunpalo, & Suni, 2004; Gilson et al., 2009; Plotnikoff, McCargar, Wilson, & Loucaides, 2005), two were randomised trials that compared two modes of intervention delivery (print and web-based) (A. Marshall, Leslie, Bauman, Marcus, & Owen, 2003), and face-to-face and telephone coaching (Opdenacker & Boen, 2008). One study had a single sample, pre–post design (Osteras & Hammer, 2006).

All interventions were found to focus on increasing physical activity as the primary outcome; reducing sitting was a secondary outcome. All the studies used self-report measures to assess sitting, four with generic questions from the International Physical Activity Questionnaire (IPAQ), which has acceptable reliability and validity (Craig et al., 2003). Only one study measured sitting at work specifically; it found a non-significant decrease in workday sitting time in one of the intervention groups, but no significant differences in workday sitting time between intervention and control groups over 10 weeks (Gilson et al., 2009). Four of the studies demonstrated that participants decreased sitting during the intervention period, but in all of these the control or comparison participants reported similar decreases in sitting (Aittasalo et al., 2004; A. Marshall et al, 2003; Opdenacker & Boen, 2008; Plotnikoff et al., 2005). The pre–post study revealed no differences in sitting time (Osteras & Hammer, 2006). Overall, these findings indicate that no workplace studies have attempted to reduce sitting in the workplace as a primary outcome; furthermore, none of those reviewed showed significant differences in sitting between the intervention and control or comparison groups.

The systematic review conducted by Chau et al. (2010) revealed that a distinct gap exists in the realm of interventions designed to reduce POS. With evidence that recognises the substantial number of hours each day that desk-based employees spend seated, there is a need to develop methods and interventions that address the reduction of

POS as a sole or primary outcome. Health implications associated with POS such as cardiovascular disease, type 2 diabetes, metabolic syndrome, unhealthy weight, and premature mortality, put the health levels of desk-based employees at risk. A pragmatic approach to reducing POS for workplaces could be the introduction of brief interruptions into occupations that are desk-based and consumed by excessive sitting. Encouraging regular interruptions that involve standing and moving may help to reduce POS, especially given the cardio-metabolic risks associated with extended periods of sitting (Healy et al., 2008). The necessity for workplace interventions to focus on reducing POS becomes even greater with the knowledge that participation in moderate-to-vigorous physical activity may not fully compensate for lengthy periods of sitting.

Recent investigations into occupations that predominantly involve sitting and low levels of energy expenditure have utilised standing desks as a strategy for reducing sitting behaviour. These are height-adjustable desks that can be manually or automatically manipulated so that they are functional at different heights. They are typically considered a reactionary strategy to treat musculoskeletal problems such as neck and back complaints (Husemann, Von Mach, Borsotto, Zepf, & Scharnbacher, 2009). The adjustable height allows the desk to be used by its operator in either a standing or seated posture, and is often viewed as an apparatus to facilitate the interruption of sitting time.

To investigate how the use of standing desks affected sedentary time in the workplace, Gilson, Burton, van Uffelen, & Brown (2011) conducted a study in an Australian open plan office. The researchers purposely targeted shared desk use within a work environment to replicate the workplace realities of limited desk availability and contemporary office design. Eleven employees wore a sensewear armband accelerometer from waking to bedtime for two consecutive working weeks. Results showed that the use of standing desks varied in the sample of employees. Their log books indicated that the standing desks promoted increased standing in some employees, but the accelerometer data showed that the desk use had no overall effect on the proportion of work time spent in sedentary behaviour. Similarly, the Take-a-Stand project conducted in Minneapolis, Minnesota (Pronk et al., 2012) examined the effect of a sit-stand device on time spent sitting at work, and assessed the effect of reduced sitting time on selected health-related outcomes, mood states, and indices of work performance and behaviour. The premise of the project was that programs designed to change behaviour in the workplace are implemented at multiple levels simultaneously, as individual efforts at changing behaviour tend to be more successful in supportive environments. Sitting, standing, and walking behaviour was monitored for the seven-week duration using Experience-sampling Methodology, which describes real-world situations by frequent sampling of a situation or behaviour (deVries, 1992). Following the seven-week research period, self-report results indicated that the project was successful at increasing non-sitting behaviour by 224 per cent, and by 66 minutes per day (a 16.1 per cent reduction in sitting time). The installation of a sit-stand device was also effective in reducing upper back and neck pain, and in improving mood states. At the end of week seven 87 per cent of the intervention group felt more comfortable, 87 per cent felt more energised, 75 per cent felt healthier, 71 per cent felt more focused, 66 per cent felt more productive, 62 per cent felt happier, and 33 per cent felt less stressed as a result of having the sit-stand device installed at their work stations. The Take-a-stand-Project succeeded in changing the physical environment of desk-based employees and recorded a significant reduction in sitting time. This overall finding is promising, as few other studies have successfully achieved this as a primary outcome, or reported complementary health benefits.

It is recognised that standing desks and sit-stand devices can change the sitting behaviours of desk-based employees, but gaps exist in the development of approaches to prompt regular, structured use. Although the collection of data in the study using standing desks by Gilson et al. (2012) used both a self-report mechanism and an objective measurement in an office setting, a number of shortfalls are apparent. The sample size was small and the measurement period was short. The gender, age, and occupation of the employees were not included in the study description. The sensewear armband is recognised as a valid measure of free-living energy expenditure, but it does not provide information on posture, activity mode, or sit–stand–move ratios. Likewise, the Take-a-Stand study by Pronk et al. (2012) did not allow for randomisation in group assignment, so causality cannot be assumed from the results. Furthermore, all data considered in this project were based on self-report mechanisms, so a certain degree of bias should be acknowledged. A point of contention is that the employees included in the study were health conscious, physically active, aerobically fit and generally healthy, and likely to respond to the intervention: these favourable attributes might not be present in other workplaces and samples. Finally, participants were not provided with any concurrent feedback regarding behaviour change during the research period, there was no form of education given to either the intervention or the comparison group at baseline, and there was no objective measure of posture and movement. The inclusion of elements such as these might have elicited further positive impacts in relation to reducing occupational sitting.

Despite increased use of standing desks in workplaces, it has been postulated that their use may not raise employee energy expenditure levels above a sedentary threshold in a controlled setting (Speck & Schmitz, 2011). To date the use of such apparatus to change POS has operated on an active prompt (or point-of-decision prompt) whereby the user consciously decides to change from sitting to standing, standing to sitting, or to remain in one of those positions. Standing desks and various other workplace interventions have been designed and implemented based on the implementation of an active prompt and an individual decision to engage with them (Fry & Neff, 2009; Swenson & Siegel, 2013). According to Soler et al. (2010), interventions framed on an active prompt generally account for only a low level of initial use. Efforts to establish health behaviour change that eventually becomes permanent often lead to acute changes that are only short lived (Dawson, Tracey, & Berry, 2008; Fry & Neff, 2009; Leslie et al, 2005; Soler et al., 2010). Ultimately this approach results in employees failing to engage consistently and regularly with interventions, and many return to previous behaviours or old habits (Leslie et al., 2005; Pressler et al., 2010): in many workplaces today this means the resumption of POS. If the objective of workplace interventions is to reduce POS and increase energy expenditure, different methods from those that function on an active prompt are required.

Increasing workplace physical activity by reducing POS

There is a need to identify methods which effectively engage desk-based employees in behaviour that improves health and supports behaviour change. Techniques that engage employees passively through interaction with desk-based technology and their office environment may be effective in the initiation and maintenance of healthy behaviour. Despite limited evidence of interventions with the primary outcome of reducing POS, the findings from two studies by W. Taylor et al. (2010) and Evans et al. (2012) demonstrate that approaches to modify the health behaviour of desk-based employees during the workday have been attempted.

A logical method to promote health and reduce POS is to take work breaks. Healy et al. (2008) found that interrupting prolonged periods of sitting was beneficially associated with waist circumference, decreased triglyceride levels, and reduced two-hour plasma glucose, in a study involving 168 adults. Physical activity breaks in the workplace have been proposed to mitigate stress and sedentary behaviour, which contribute to type 2 diabetes, unhealthy weight, heart disease and other chronic conditions (Hu et al., 2003; Lucini , Riva, Pizzinelli, & Pagani, 2007; Mummery et al., 2005). According to Malachowsk (2006), Sarna et al. (2009), and C. Taylor (2005), work breaks are underutilised, and typically morning and afternoon work breaks include smoking cigarettes, drinking coffee, consuming high calorie low nutrition snacks, and social use of the internet. Attempts to incorporate physical activity breaks in the workplace have included combinations of aerobic activity, flexibility, stretching, and muscular toning activities, all of which have the potential to affect employee health directly and indirectly by inducing a ‘spill-over’ effect by which physical activity outside the workplace also increases (W. Taylor et al., 2010). Physical activity breaks have the added potential benefits of promoting a healthy workplace culture and increasing productivity (C. Taylor, 2005). Despite the endorsement of physical activity breaks in the workplace for their proposed health benefits, there is scant evidence from randomised controlled trials that physical activity breaks do improve health outcomes. One possible explanation for this paucity of evidence is that often workplace managers and administrators have noble intentions to promote employee health and physical activity, but over time these are overlooked, with work duties and productivity often taking priority over health.

To evaluate the feasibility and sustainability of physical activity work breaks in daily practice, W. Taylor et al. (2010) undertook an innovative approach by implementing organised, routine work breaks intended to improve physical and psychological health, enhance job satisfaction, and sustain or increase work productivity.

The intervention was titled ‘Booster Break’, and focused on peer-led group sessions devoted exclusively to standard 15-minute work breaks during each workday during which participants performed the Booster Break routine in their work clothes. The primary focus of the pilot intervention was health promotion rather than injury prevention, and the routine was designed to increase participants’ blood circulation, flexibility and relaxation in a socially supported context. Booster Break sessions were conducted in the worksite each workday at 11:45 am for 14 employees (eight females and six males) aged between 32 and 66 years. Participants selected a Booster Break buddy and completed a form as part of their commitment and pledge to work together with their buddy, providing support and motivation throughout the six-month period. To assess physical activity patterns the International Physical Activity Questionnaire (Craig et al., 2003) was administered; and a pedometer was used to objectively measure for one week at baseline and for one week after six months for all hours other than when sleeping or showering. Blood pressure, lipid assessments, height, weight, and waist girth measurements were taken at baseline and six months.

Results from Booster Break pilot program (W. Taylor et al., 2010) showed that overall compliance was greater than 80 per cent over the six-month trial period. The strong attendance record indicated that health-promoting work breaks were feasible and sustainable in a small workplace. Behavioural data displayed subjective and objective increases in physical activity and decreases in sitting time, although these were not statistically significant. Sitting time during weekdays decreased from 600 minutes to 394 minutes ($p = 0.34$), and on the weekend from 265 minutes to 222 minutes ($p = 0.50$). HDL cholesterol significantly improved ($p = 0.04$) over the six months, and an average weight loss of 14 pounds (over six kilograms) was observed. Systolic and diastolic blood pressure, waist circumference, LDL cholesterol, and total cholesterol were not significantly different from pre-test to post-test assessment. No significant changes were found for the psychosocial variables self-confidence, enjoyment, benefits, barriers, social support from friends, family, and co-workers. Although not statistically significant, social support for physical activity from co-workers increased during the six month period. There were no discernible patterns of improvement in quality of life and perceived stress measures.

These findings demonstrate that daily15-minute routine physical activity breaks provide a convenient, simple, minimal-resource approach to workplace health. Subjective and objective measurements revealed improvement in physical activity levels, weight loss and HDL cholesterol, along with a decrease in sitting time. Although the intervention did not aim to influence sitting time and weight loss, these findings are positive health outcomes and argue for the deployment of daily movement breaks in the workplace. The small sample size diminishes the power to detect statistically significantly differences in the measured outcomes, so drawing precise conclusions is difficult; and the study did not include a control group, so the capacity of the program to influence workplace physical activity cannot be generalised from its findings. In addition, there was no assessment of caloric consumption and eating habits during the trial, and these may have influenced weight and physiological measures. Finally, the study did not incorporate an objective measure of sedentary behaviour, which would have provided more accurate data in relation to the sitting behaviours of the employees.

Introducing the model of a daily movement break during work hours for desk-based employees offers a starting point for a feasible approach to reducing POST. It is possible that some employers, managers, and administrators in larger organisations would consider one continuous 15-minute work break too long to spend away from work duties, and would be against such a concept. Presumably within an organisation of over

100 employees it would take more time, effort, and increased workplace infrastructure to be able to execute an intervention such as the Booster Break effectively and successfully, leading to more resistance to implementation. Introducing short breaks regularly throughout the workday rather than one continuous bout is an option that offers an alternative to being physically active for just one period of time. The notion of regularly interrupting POS throughout the workday could limit the adverse health effects commonly associated with sitting for the majority of the day while at work, and the prospective benefits of embedding short one- to three-minute NEAT movement interruptions are increasing energy expenditure, enhancing muscle stimulation and activation of lipoprotein lipase, providing a short mental and emotional break from desk-based duties, and a refreshment of mental alertness and concentration. Currently gaps exist in the literature around the effectiveness of short bouts of movement regularly throughout the workday to benefit health.

To investigate the efficacy of interrupting POS on the total sitting time of office workers, Evans et al. (2012) applied point-of-choice prompts through computer prompting software. The study incorporated an active–controlled randomised trial that compared two groups of office workers, using a convenience sample of 30 healthy working adults. Random number generation was used to place participants into either the group who received education only, or the point-of choice-group who received the same education along with prompting software on their personal work computers that reminded them to stand every 30 minutes. Participants wore an activPAL (PAL Technologies, UK) at work for five workdays, recording time of arrival at work (monitor application) and time of departure (monitor removal) in a diary. The thigh-mounted activPAL provides time-stamped acceleration, classified into sitting/lying, standing, and walking.

At baseline all participants individually received a short educational talk. They also read a script regarding the health risks of POS, which stated that standing every 30 minutes could be beneficial, and received a short information booklet. Participants in the point-of-choice prompt group had prompting software (MyRestBreak1.0) loaded onto their PC, and this was activated for the five-workday intervention period. An advice window reminding participants to take a break appeared on the monitor for one minute every 30 minutes from the time the PC was started. The window could not be minimised or moved, but participants could continue to work unimpeded. A prolonged sitting event was defined as greater than or equal to 30 minutes, with total sitting time and number of sitting events (equivalent to the number of breaks from sitting) used as outcome measures to represent overall sitting behaviour.

Results from the five-day trial of point-of-choice prompts to reduce POS and total sitting time (Evans et al., 2012) indicated that objectively there was no difference in total sitting time between baseline measurement and intervention measurement in all participants, but there were significant between-group differences in the total number of sitting events per hour, and in the length of prolonged sitting events. Both the number of sitting events and the time spent sitting for longer than 30 minutes were reduced in the point-of-choice-plus-education group, and differed from the lack of change in the education-only group. The intervention reduced the number of and the time spent in uninterrupted sitting periods, compared to education alone. This finding provides evidence that to stimulate health behaviour change at the workplace, education alone is not sufficient; education coupled with a prompting reminder is a more effective option. This finding is supported by research conducted by Smith, Pedersen, and Cooley (2013) who found that coupling education with a workplace intervention was effective for decreasing POS in desk-based employees.

A notable outcome from the study by Evans et al. (2012) is that the point-of-choice prompt was effective in increasing the number of times participants interrupted prolonged periods of sitting throughout the workday, thereby reducing POS. From this it could be postulated that the use of a periodic computer-based prompting reminder is an effective approach to encourage desk-based employees to remove themselves from a seated position and at least stand. Although the point-of-choice prompt was not passive in that the participants could continue to work while the reminder remained on their screen, it may have been effective in getting them to cognitively remind themselves that they need to stand, or possibly even to stand and move. However, there were some shortcomings of this study, including its small sample size, the shortness of the intervention period, and lack of long-term follow-up. There was no process evaluation to ascertain if the intervention was delivered as intended or whether participants found it useful. The inclusion of education might have influenced participants engaging with the program, if the prompt function triggered a cognitive association with the health risks characteristic of POS and cued them to stand.

Extending from the work of Evans et al. (2012), developing a prompt that is delivered through a personal computer at work that is designed to reduce POS and increase workplace NEAT movement is an interesting proposition. Establishing an intervention for the workplace which is framed on a passive prompt may be a valid approach to changing desk-based employees' sitting behaviour at work.

If the solitary aim of a workplace intervention is to limit POS, then additional methods need to be integrated that increase energy expenditure. The negative cardio-metabolic health consequences that accrue from increasing POS are largely caused by continuous uninterrupted periods of sitting; therefore, the most logical approach to negating these adverse effects is to encourage individuals to stand and move. To date there is a dearth of evidence to substantiate a specific approach to decrease POS. Previous methods have shown that a variety of techniques are effective in getting people to stand from their seated position, but what happens once this occurs in terms of health benefit is largely unknown.

Passive Approaches to Changing Health Behaviours

A common view expressed by health experts and professionals in previous years is that health has been analysed with the belief that individuals have the right to choose to engage in health behaviours on the basis of their own best interests. This view has been shared by both government and private organisations, which have called for an increase in individual responsibility for health and health care (National Centre for Health Education, 1980; Office of the Surgeon General, 1979).

Lalonde (1974) proposed that self-imposed risks and the environment are the main influences on the health of all age groups, based on the notion that individual behaviours, often the everyday habits and choices relating to diet, smoking, driving behaviour, taking alcohol and other drugs, and lack of exercise, directly or indirectly contribute to poor health and eventual death. From this it would seem logical to many that if individual behaviour is the cause of health problems, individual change must be the solution (Forster, 1982). In contrast, collective efforts and interventions have been recommended to protect entire communities from poor health, on the grounds that exposure to poor health and the associated personal effects of poor health can be minimised through mandatory, universal, passive strategies (G. Baker, 1991). An example of this is sanitation and the control of infectious diseases, which has been accomplished by analysing problems in terms of host, agent, and environment (Forster, 1982). In principle, individual interest is insufficient to support efforts to solve persistent health problems, and interventions that change individual behaviour may lead to unwelcome health outcomes (Forster, 1982). Thus, a communitarian approach to improving health may be justified.

A communitarian model is based on the idea of community as a social value. The model emphasises commonality, inclusiveness, cooperation, solidarity and community as an end in itself, rather than being an instrument for achieving individual ends (Forster, 1982). Although community is voluntaristic in nature, it has been argued that voluntarism is not an essential component of the communitarian ethic (Price, 1977); common good supports communitarian values. Forster (1982) argued that a communitarian approach was required to achieve the public health goal of reducing traffic injuries through the use of passive auto restraints. This approach was formulated in the knowledge that in the United States only 10 per cent of front-seat occupants in automobiles made use of safety belts from their inception in 1964. Despite an almost twenty-year media campaign worth millions of dollars, seat belt use did not change in response to any of the methods used to promote voluntary compliance, although surveys showed that 90 per cent of the public expressed positive attitudes towards seat belt use (Fhaner & Hane, 1973; Phillips, 1980; Robertson et al., 1964), and over 50 per cent of non-seat belt users favoured compulsory use (Fhaner & Hane, 1973). The factor which contributed most significantly to non-use was habit.

Forster (1982) maintained that the goal of preventing death from causes such as traffic injury was best validated and accomplished by appealing to communitarian values. Such problems cannot be solved without collective measures because individual interest is not sufficient motivation for behaviour change if the perceived risk to the individual is low. If a collective goal such as reducing traffic injury is recognised and valued interdependently and as a mutual responsibility (Forster, 1982), preventative behaviour such as seat belt use makes sense and becomes important. Collective measures like passive restraints to reduce traffic injury represent protocol to control hazards rather than change behaviour, prevention through control of the social structures which expose people to hazards, and communal responsibility rather than self-interest (Forster, 1982); referred to as the traditional mandate of public health. This passive approach prompts people to accept that public health is a matter of community concern, that public health problems are linked to social and economic situations, and that structural mechanisms are required to control these problems (Rosen, 1974; Winslow, 1929). Based on this, it is reasonable to suggest that persistent social problems such as POS and the absence of regular movement, which have been targeted by individual strategies and interventions, have not been ameliorated. Replacing individual strategies and interventions with approaches that reinforce communitarian values and identify shared concern for the health of the community may offer a better approach to reducing POS.

The communitarian model described by Forster (1982) is underpinned by a passive approach to prevention. Passive prevention requires minimal or no action regardless of any personal decision, with common examples being fluoridated water, childproof caps on poisons, milk pasteurisation, and environmental improvements for health and safety such as wearing a hard hat at a construction site (Roberts, 1987). Moreover, passive approaches rely on changing products or environments to make them safer or more accessible for all, irrespective of the behaviour of individuals (Gielen & Sleet, 2003). Previous passive approaches to promoting physical activity have included limiting central business districts to foot or bicycle traffic, locating car parks at walking distance from buildings, building communities where businesses and schools are adjacent to residential areas and connected by networks of public transportation, bicycle paths and walking paths, and making stairways more appealing and user-friendly (Mansi, Mansi, Shaker, & Banks, 2009). The unique characteristic of a passive approach is that individuals are not given the opportunity to cognitively and consciously process the merits of a situation that requires a decision; instead the stimulus for the selected behaviour is provided for them. Essentially, by removing choice an individual is given no option other than to engage with the passively prompted opportunity or to remove from the situation or environment. In light of this, a workplace intervention containing a passive prompt that can stimulate desk-based employees to interrupt their POS may be a solution to changing behaviour.

Research investigating public health has asserted that better interventions come from passive techniques that are applicable to communitywide populations (Roberts, 1987). This is supported by S. Baker (1980), who claimed that passive prevention will prove maximally effective because such protection is totally independent of the wisdom, caution, skill, and psychological makeup of the individuals who are protected. These contentions extend from debate in the public health discipline throughout the 1980s relating to the active–passive dimension, and the distinctions between active–passive, individual–population approaches. Williams (1982) viewed active and passive as opposite ends of a continuum, suggesting that both methods have important roles in the health domain. When this perspective is applied to the habitual behaviour of POS exhibited by desk-based workers, a rational tactic to change or interrupt this behaviour would be to passively prompt the workers. The prompt could function as an unconscious reminder to employees: the intention is to get desk-based workers to stand and move, which incorporates a conscious self-selection and controlled approach to choosing for how long, with what intensity, and with what type of movement they will participate. Once an employee is passively prompted to change their POS behaviour and move, their active behaviour is based on personal decision. This example demonstrates how passive and active approaches can combine to interrupt POS and increase voluntary movement at the workplace.

A method for improving employee health and recognising the environments which influence behaviour in the workplace is through the adoption of a social ecological model (Bronfenbrenner, 1992). A social ecological model cultivates the opportunity to establish structural modifications through the interaction of organisational, political, social, physical, and environmental changes. To enable this to occur effectively, the behaviour of key decision makers at all organisational levels needs to be influenced (Roberts, 1987). This approach can foster a mutual recognition that health problems, such as POST, cannot be solved in any other way than through a multilevel system; thus, a multifaceted passive environmental approach targeted at numerous levels of intervention is needed (Roberts, 1987). If such an approach is implemented to reduce POS in the workplace, then it is possible that all desk-based employees will develop the habit of interrupting their sitting and engage in regular NEAT movement in the workplace.

There is a need for workplace interventions to be innovative in approach and design so that a broad audience is captured, not just individuals who are already physically active and health conscious. A variety of evaluative techniques such as objective measures, self-report measures, and qualitative evaluation are necessary to develop clear findings that are valid and reliable, which a single method may be unable to do. Workplace interventions that are predicated on a theoretical framework, feature a passive prompt that removes conscious thought and decision-making, and allow for a level of user control may be effective in encouraging sustainable health behaviour change. If these elements can be united at multiple organisational levels, then the development of healthy habits in the workplace might facilitate a healthy culture and climate.

The current study

The aim of my research is to investigate the effectiveness of periodically interrupting POS with short bouts of NEAT throughout the workday to reduce the health risks associated with POST. The conceptual framework adopted to test the effectiveness of a workplace intervention to change health behaviour is constructed upon a social ecological model, used to influence the sitting and movement behaviours of desk-based employees because the intervention is predicated on how employees interact with the physical and social workplace environments at individual, co-worker, cultural, biological, political and organisational levels. A reason for the use of a social ecological model is that many previous studies examining physical activity behaviour have been based upon psychosocial and social theoretical models which primarily target behaviour change at the individual level, limiting their applicability to community and multidisciplinary context. Furthermore, the present workplace intervention attempts to modify how desk-based employees engage with the physical and social environments at multiple levels by transforming typical barriers to movement into enablers of movement: a social ecological model is a sensible approach to a social and ecological problem.

To test the proposition that a workplace intervention predicated on a social ecological model could improve the health of desk-based employees, a randomised controlled trial was conducted, the gold standard for any field-based research (Simon, 2001). According to Campbell and Stanley (1963) random assignment contributes so much to internal validity that the term ‘true experimental design’ has been used to represent this methodological approach. A repeated measures (pre-test, post-test) research design was employed on field-specific dependent variables. These included a self-report of workplace energy expenditure (OPAQ: Reis et al., 2005); a battery of pathological assessments including blood pressure (Mittal, Arora, Bachhel, & Singh, 2011; Prescatello, Fargo, Leach, & Scherzer, 1991), blood glucose (Healy et al., 2008), cholesterol (Leon & Sanchez, 2001; Stefanick et al., 1998), and triglycerides (Thompson, Crouse, Goodpaster, Kelley, & Pescatello, 2001); a self-report of health (SF-36: Stewart, Hays, & Ware, 1988); and a self-report daily frequency of participation measure to determine compliance to the intervention. These dependent variables were measured and are reported on as detailed below.

The study was divided into two parts: Study A and Study B. In each study different cohorts underwent an induction session at baseline, which included education on the adverse health effects of POS, based on previous research by Evans et al. (2012) and Sallis, Floyd, Rodriguez, and Saelens (2012), who demonstrated the value of health education on behaviour change. Study A was a randomised controlled trial conducted over a 13-week period and included pre- and post-test physiological and workplace energy expenditure measurements. Research has demonstrated that physical activity has a positive effect on many of the established risk factors for cardiovascular disease (Giannuzzi et al., 2003), preventing or delaying the development of high blood pressure in normotensive subjects and reducing blood pressure in people with hypertension, reducing cholesterol levels, and lowering the risk of developing non-insulin dependent diabetes (Fletcher et al., 2001; US Department of Health and Human Services, 1996). The majority of research in the realm of physical activity has centred on sustained aerobic activity, and evidence suggests that the likelihood of myocardial ischemia is reduced with decreases in heart rate and blood pressure (Fletcher et al., 2001; US Department of Health and Human Services, 1996). Less is known about the physiological impact of interrupting POS regularly with short bouts of NEAT movement.

To investigate this, the physiological biomarkers of blood pressure, blood glucose, cholesterol and triglycerides were measured in Study A.

It has been reported that blood pressure is prone to elevate in the workplace because of employer and employee perceptions of performance and productivity, high psychological demands, and the organisational approach to health (McCraty, Atkinson, & Tomasino, 2003; Myers, 2003; Schnall et al., 1990). Measuring the blood pressure of participants might be a useful method to gauge if an intervention does effectively engage them, as numerous reports have indicated the beneficial effect of physical activity on blood pressure (Bouchard, Blair, & Haskell, 2007; Fletcher et al., 1996; Warburton, Nicol, & Bredin, 2006). To date there is scarce evidence related to the impact of short bouts of NEAT movement on blood pressure. According to Healy et al. (2008), time spent in in light intensity activity may have metabolic health benefits independent of time spent in more intense activity. Based on this argument, blood glucose, cholesterol, and triglycerides were measured pre-test and post-test in an experimental group and a control group. In Study A the variable cholesterol was reported as total cholesterol, the combination of LDL (low-density lipoprotein) and HDL (high-density lipoprotein) cholesterol (Baker IDI Heart & Diabetes Institute, 2014).

A secondary aim of Study A was to assess if the intervention was effective in reducing POS and increasing energy expenditure in the workplace. For the most part, research measuring energy expenditure in the workplace has used the International Physical Activity Questionnaire (Craig et al., 2003); but the data it has produced are limited because the various sources of energy expenditure are not differentiated. To address this limitation, Reis et al. (2005) developed the Occupational Physical Activity Questionnaire (OPAQ), a self-report measure of workplace energy expenditure determined by the time per week that employees spend in three categories;

sitting/standing, walking, and performing heavy labour. Prior to the selection of the OPAQ, other self-report measures for sitting were considered for use, but were deemed not suitable based on questionnaire length, data gleaned from the measure, and accessibility for participants during the study. These other measures were the Sedentary Behaviour Questionnaire (Rosenberg, Norman, Wagner, Patrick, Calfas, & Sallis, 2010), and the Marshall Sitting Questionnaire (Marshall, Miller, Burton, & Brown, 2010). The use of OPAQ in this study was to gauge if the workplace intervention impacted upon daily energy expenditure over a 13-week period.

Study B was conducted to determine the capacity of the workplace intervention to instigate and sustain workplace health behaviour change in desk-based employees. An additional aim was to address gaps in the findings from Study A. Previous investigations of workplace interventions have demonstrated trends suggesting that short-term responses to health behaviour change are effective, but adherence to health behaviour change long-term is less effective (Leslie et al., 2005; Napolitano et al., 2003; Robroek, van Lenthe, van Empelen, & Burdorf, 2009). The research period for Study B was 26 weeks, made up of two 13-week periods where participants were exposed to a workplace intervention. This time frame was based on previous research by Lally et al. (2010), who found that on average people take 66 days to form a habit; 13 weeks at the workplace is the equivalent of 65 days. During the first 13 weeks of this study participants were prompted passively to engage with the intervention, framed upon previous research by Forster (1982) and Roberts (1987), who utilised passive intervention to promote health and disease prevention at a community level. During the second 13 weeks participants were prompted actively to engage with the intervention, the aim being to monitor if they were able to sustain any behaviour change that had occurred during the passive prompt period. The purpose of this was to assess if a health habit had been developed and could be sustained, or if participants reverted to previous POS habits.

The distinction between the passive and active prompt periods of this study lies in how the passive prompt engaged the intervention group, compared to how the intervention group engaged with the active prompt. A self-report daily frequency of participation measure was recorded electronically throughout the intervention, during both the passive and active prompt periods, to calculate POS behaviour. The frequency of participation in interrupting POS and engaging in short bouts of NEAT movement per day during the passive and active prompt periods functioned as a measure of compliance to the intervention. To ascertain participants’ perceptions of health, the Short-Form 36 (SF-36) was completed at baseline, at 13 weeks, and again at 26 weeks. SF-36 has previously been used as a measure in a variety of different domains such as hospitals and health care facilities, and with physical and psychological rehabilitation cases (Ware, 2000). Prior to the year 2000 it was documented in more than 1000 publications. This quasi-quantitative measure was included to determine if the intervention was effective in changing POS behaviour, and if any behaviour change was maintained.

An action research approach was implemented for Study B, and hence the participants were organised into one group (Mills, 2003). This approach was adopted to gather data on the effectiveness of a workplace intervention, and to gain insight into methods for making positive change (Anshel & Kang, 2008). The intervention in Study B was designed to monitor how desk-based employees adapt to specific health behaviours.

Considering the adoption of the social ecological model as the underlying framework for this research study, a purely positivist approach was deemed insufficient to interpret the dependent variables described above. A post-positivist approach using a phenomenological method to capture the lived experiences of the participants while undergoing the experiment was incorporated (Lester, 1999; Wildemuth, 1993). Fifteen participants were randomly selected for individual interviews both during and at the conclusion of Study B to gather information regarding the social and ecological enablers of and constraints to their workplace health behaviour. Their responses were analysed using literature-driven themes relating to the effectiveness of the workplace intervention (Renton, Lightfoot, & Maar, 2011; Spittaels & De Bourdeaudhuij, 2006), and triangulated with the self-reported measures of health and wellbeing (Stewart, Hays, & Ware, 1988) and of compliance.

This triangulation (Miles & Huberman, 1994) regarding the application of a social ecological model to workplace health behaviour was utilised to gain a comprehensive understanding of influences on workplace health behaviour. The collection of self-reported data gathered by questionnaire, self-reported data of frequency of participation through the intervention, and semi-structured interviews, fostered triangulation to enhance the quality and strength of the findings. The data were gathered at three different time points, and so could be time triangulated to determine if similar or divergent findings occurred at the different time points (Kimchi, Polivka, & Stevenson, 1991). Triangulation is further discussed in Chapter 4.

The justification for the design of Study A and Study B is based on the aim of the research and the research questions. First, an interest in detecting if the workplace intervention was effective in influencing physiological indicators of health and influencing workplace health behaviour by reducing POS. Second to discover if the intervention was able to promote behaviour change in terms of reducing POS and subsequently increasing energy expenditure through NEAT movement. Third, to develop knowledge regarding if the intervention was able to instigate behaviour change related to POS, and if so, would this change be sustainable over an extended period of time once the intervention was user-operated. The methodological approach of using semi-structured interviews was based on previous research that used interviews to gather participant perceptions related to workplace physical activity interventions and promotion (Renton, Lightfoot, & Maar, 2011; Spittaels & De Bourdeaudhuij, 2006). A random selection of participants (*n* = 15) were interviewed individually in their office space, once during the 13-week passive prompt period, once immediately after this period, and once during the 13-week active prompt period. C. Anderson (2010) reported that qualitative interview data based on human experience are powerful and at times more compelling than quantitative data, and that complexities of a research topic which are often missed by more positivistic enquiries can be discovered through the interview method.

A mixed methods research design was employed to provide a greater understanding of the impact a workplace intervention has on the POS behaviour of a cohort of desk-based employees. According to Cresswell (2003), including only quantitative or qualitative methods falls short of the comprehensive approaches being used today in human and social sciences. When the strengths of both quantitative and qualitative data are combined, a unified and deeper comprehension of research problems is achieved than either approach alone can provide (Cresswell & Plano Clark, 2007). Through the combination of quantitative physiological measures, self-reported energy expenditure, self-reported health, self-reported compliance measures, and qualitative semi-structured interviews, the research could ascertain empirical evidence to support or negate hypotheses, and to add to the field of prolonged sitting and health. In their review of workplace interventions to reduce sitting, Chau et al. (2010) highlighted the need to explore the effects of regular breaks in occupational sitting, a necessary prerequisite for the development of workplace interventions that specifically target and effectively reduce sitting; the use of objective measures to assess domain-specific sitting; and methodologically rigorous research to address the emerging public health issue of sitting. The intention of the present research is to respond to and provide evidence to address these outcomes.

Previous research has identified methodological problems of field-based research, such as the limitations of recall with self-report measures (Warren et al., 2010), sampling (Zelditch, 1962), and raised expectations from study participants (Koch & Rhodes, 1979). In addition to these characteristic challenges, this study was constrained at organisational level as throughout the research period several participants took annual leave, sick leave, or work-related leave. These periods of leave varied in terms of duration, and these participants' access to the intervention was not always continuous throughout the experimental period, so that a number did not complete this period at the same time. Some participants on leave were not able to attend pre-organised dates for post-test measures; their measures were completed at a later date, or in some cases not completed for that research period. These data will be reported in Chapter 3.

A small number of participants changed their occupation within the organisation during the research period; this led to a break in their access to the intervention. Those affected were able to complete the study, but with a later finishing date. A change of occupation for five participants meant relocation to a new geographical environment. These participants completed their post-test measurements at a later date, or were unable to complete them for that research period.

As this study was conducted within an organisation that is geographically distributed throughout Tasmania, the Tasmanian Department of Police and Emergency Management, workplace sizes and environments differed between stations and offices.

For example, a station based in a city included over 400 staff members, with some shared offices housing over 30 staff. In contrast, a rural station included fewer than 10 staff members, each of whom had their own office space. Social ecological factors such as office space size and area, fellow colleagues, and workplace ethos may have influenced how different participants engaged with the intervention.

Chapter 3

Study A

The distinct gap in the sphere of interventions to reduce POS identified by Chau et al. (2010) was the trigger for this study. As a primary outcome, this study was designed to interrupt POS and measure the effect of this on the health of a cohort of desk-based employees. As previously noted by Healy et al. (2008), encouraging regular interruptions from desk-based work by standing and moving to eradicate the cardio-metabolic risks associated with POS provoked interest in examining the physiological impact of interrupting POS. To date the majority of research investigating workplace interventions designed to improve employee health has focused on activity during the lunch hour, before work, or after work (Quyen et al., 2013; P. Taylor et al., 2013), highlighting a lack of understanding of how employees spend time throughout the workday. Of the small number of studies that have investigated employee sedentary behaviour and activity, several have been conducted using accelerometers (Owen et al., 2010; Parry & Straker, 2013). Some researchers have used accelerometry measures to assess movement behaviour, but limitations to this approach, such as the inability to provide sufficient evidence to gauge sedentary behaviour accurately, have been identified (Janssen, 2013). In light of this, the current study adopted an innovative approach to measuring interruptions to POS and employee health.

Over the past two decades the awareness and attention directed towards movement data has extended beyond that of researchers, with individuals, groups, and communities curious about associated movement number and statistics. Coinciding with the increased interest in daily movement is the diverse range of tools available to broad populations to aid collection of such data. Pedometers are specifically designed to count daily steps, and were one of the first devices used in the workplace to motivate and monitor physical activity, yet they do provide only one data source and studies have been criticised for attracting staff who are already active (Thomas & Willliams, 2006). Expanding on the capability of pedometers, the Fitbit device detects and stores steps taken, intensity of physical activity performed, duration of activity, distance travelled, and estimated caloric expenditure (Pina, Ramirez, & Griswold, 2012). Although possessing consumer appeal, a systematic review of wearable activity trackers (Evenson, Goto, & Furberg, 2015) found that different fitbit devices can be prone to under-estimation of steps, and over-estimation of moderate-to-vigorous physical activity. Even smartphone devices now feature applications to track health behaviours and provide convenient feedback (Patel, Asch, & Volpp, 2015). Whilst the validity and reliability of smartphone applications has undergone scant investigation, a study using small convenience sample of healthy university students found that smartphone applications were accurate for tracking step count (Case, Burwick, Volpp, & Patel, 2015). Despite the attractiveness and user friendly nature of wearable devices and mobile applications to obtain movement data, questions surrounding the accuracy of measurement and interpretation persist. Thus, to encapsulate valid and reliable sedentary and physical activity data of workplace employees, researchers should look beyond apparatus such as pedometers, fitbits, and smartphone applications.

Recent research investigating sedentary behaviour and physical activity has relied on objective measures such as accelerometers to collect data (Atkin et al., 2012). Reported benefits of these objective measures are that they gather real-time data over long periods of time, and store large amounts of information without the presence of a researcher (Castillo-Retamal & Hinckson, 2011). Key limitations of objective measures are that they do not assess intensity of movement and thus are less able to distinguish between postures such as sitting, lying, and standing (Atkin et al., 2012). In addition, upper body movement is not always detected as these devices are placed around the waist, and often expertise is required to process, clean, and analyse data (Castillo-Retamal & Hinckson, 2011). Despite the increasing popularity of objective measures to assess sedentary behaviour and physical activity, and associated energy expenditure, several studies have used subjective measures to assess these behaviours (Blair & Brodney, 1999; Bryant et al., 2007; B. Clark et al., 2011; S. Marshall & Ramirez, 2011). In the workplace self-report techniques such as surveys do not disrupt work flow, permit access to large samples, require only short periods of time to complete (Mummery et al., 2005), are cost effective, and have a relatively low participant burden (Atkin et al., 2012). According to Castillo-Retamal and Hinckson (2011), subjective measures are the most common way to gather data when behaviours are studied because more information can be collected. Surveys are the most frequent tool used to determine sedentary behaviour and physical activity in the workplace. Based on this, and because the participants in this study were geographically spread around Tasmania, workplace energy expenditure would be measured using a validated survey method. Study A was conducted in 2010.

Study Design

Study A involved an experimental group who received a workplace intervention and were compared with a control group who did not receive the intervention. The intervention was designed to interrupt POS and increase NEAT in a cohort of desk-based employees during the workday. The primary aim of Study A was to examine the impact of the intervention on employee health over a 13-week period. The time frame was based on research by Lally et al. (2010), who found that the average time for adults to change a specific health behaviour was 65 days. To measure employee health a combination of a self-report inventory and multiple objective measures were completed at the pre-test stage, prior to, and at the post-test stage at the conclusion of the thirteen weeks. The data collection methods used in this study were designed to provide evidence to address research question 1 of this thesis:

> **RQ_1:** Can a workplace intervention designed to interrupt prolonged occupational sitting improve the health of desk-based employees?

For this study, health was operationally defined by three dependent variables which functioned as data collection methods. First, perceptions of workplace energy expenditure were self-reported by the participants using the Occupational Physical Activity Questionnaire [OPAQ] (Reis et al., 2005). Second, blood pressure measurements were recorded to assess the impact on this physiological biomarker of interrupting POS. Systolic and diastolic measurements were reported, and from these mean arterial pressure (MAP) was calculated. MAP is the average pressure throughout one cardiac cycle (Meaney et al., 2000). Third, to explore the physiological impact of interrupting POS more comprehensively, the physiological biomarkers blood glucose, cholesterol, and triglycerides were measured. Participants' perceptions of occupational physical activity, their blood pressure and blood measurements, provided the basis for the evaluation of their health. The independent variable was an interactive computer-based software program designed to prompt employees to interrupt long bouts of sitting by standing up to engage in a brief bout of NEAT periodically.

Based on these operational definitions of health three hypotheses were designed which were grounded on the passive nature of the intervention prompt and the promotion of short bouts of NEAT into the workday, and previous research advocating the physiological benefits of regular physical activity on various physiological biomarkers (Blair, 2010; Fletcher et al., 1996; Warburton, Nicol, & Bredin, 2006):

> **N_0:** A workplace intervention designed to interrupt prolonged occupational sitting will not improve the energy expenditure of desk-based employees.

H_1: A workplace intervention designed to interrupt prolonged occupational sitting will improve the energy expenditure of desk-based employees.

N_0: A workplace intervention designed to interrupt prolonged occupational sitting will not improve the mean arterial pressure of desk-based employees.

H_2: A workplace intervention designed to interrupt prolonged occupational sitting will improve the mean arterial pressure of desk-based employees.

N_0: A workplace intervention designed to interrupt prolonged occupational sitting will not improve the blood glucose, cholesterol, and triglycerides levels of desk-based employees.

H_3: A workplace intervention designed to interrupt prolonged occupational sitting will improve the blood glucose, cholesterol, and triglycerides levels of desk-based employees.

A non-invasive self-report of workplace energy expenditure was completed by both the experimental group and the control group, to provide evidence to respond to Research Question 1. A non-invasive blood pressure measurement for both groups was taken, to gain a more in-depth understanding of the physiological impact of the intervention on participants' health. To further investigate the physiological impact of the intervention, blood glucose, cholesterol, and triglycerides were taken from participants in both the experimental and control groups to provide evidence to respond to Research Question 1. The measurement of blood glucose, cholesterol, and triglycerides is the principal method used to assess the prevalence of cardiovascular morbidity and mortality (Isomaa et al., 2001).The dependent variables investigated through these measures were perceptions of workplace energy expenditure, mean arterial pressure, blood glucose, cholesterol, and triglycerides.

Participants

Desk-based employees from the Tasmanian Department of Police and Emergency Management (TDPEM) were invited by their occupational health and safety officer to participate in the study. The TDPEM is represented by 70 stations geographically spread throughout the state, varying in size and infrastructure. As this study was the first of its kind a power analysis was not conducted because of the lack of available related data. Participants (*N* = 46) were randomly selected from 460 volunteer desk-based TDPEM employees, using a computer-based random number generator that took into account the number of desk-based employees in each of the south, north, and north-west regions of the state, and the percentage of desk-based employees specific to each region. Ten per cent of TDPEM desk-based employees was deemed a manageable sample size for a PhD project by the supervisory team. The research team consisted of me, the PhD student, two PhD supervisors, and the TDPEM Occupational Health and Safety Officer. The participants' occupations included reception duties, administrative support, call centre, forensic analysis, community liaison, media liaison, transcription, and sworn duties. Participant demographic details are provided in Table 1.

Table 1

Participant demographic data. Values are means (*standard deviations*)

Gender (N = 46)		Age (years)	Weight (kg)	Height (cm)	Body mass index (%)
Female	33	41.5 (*12.2*)	72.22 (*13.73*)	164 (*6.18*)	27.78 (*4.55*)
Male	13	46.1 (*6.8)*	95.38 (*18.36*)	177 (*5.41*)	30.09 (*5.29*)

The participants were pre-screened to determine if they met the inclusion criteria: that all participants were full-time employees who worked eight-hour daily shifts and primarily had desk-based job responsibilities; who used a desktop personal computer to perform their work; who were prepared to engage in behaviour change; who were operationally defined as being in either the contemplation, action, or termination stage of Marcus, Rossi, Selby, Niarua, & Rossi's (1992) stages of change categories; and were medically healthy to perform short bouts of daily physical activity (PAR-Q: British Columbia Ministry of Health, 1978). PAR-Q requires all participants to answer 'yes' or 'no' to seven questions regarding health and physical activity. The questions are framed around the presence of a heart condition, chest pain, losing balance because of dizziness or losing consciousness, joint problems, current prescription drugs for blood pressure or heart condition, and any other reason that physical activity should not be performed. If a participant answered 'no' to all questions or 'yes' to one question but had received and produced clearance from a general practitioner, they were deemed medically able to perform short bouts of daily physical activity. If a participant answered 'yes' to more than one question then they were excluded from the study. Based on these criteria no participants were excluded. All volunteers provided informed consent prior to data collection, in accordance with University of Tasmania ethics requirements (Appendix A).

A limitation of this study was that not all the participants (n = 46) completed measurements for blood pressure (n = 27), blood glucose (n = 29), cholesterol (n = 29), and triglycerides (n = 29). Reasons ranged from a medical recommendation not to give blood, being on sick leave or work-related leave at the times of testing, and not fasting the night before testing for blood glucose, cholesterol, and triglycerides occurred.

Procedures

Participants were randomly assigned with replacement to either the experimental group who received the intervention (*n* = 20; *mean age* = 41.50 +/-12.39) or to the control group who did not (*n* = 26; *mean age* = 44.88 +/-9.65). Random assignment with replacement refers to each participant having an equal chance of being assigned to either the experimental group or control group, with each group assignment replaced after being assigned to allow for randomisation (Lachin, 1988). To achieve random assignment, each participant was provided with a personal identification number, and these numbers were assigned to groups by a random numbers computer generator. Randomisation is paramount in the research design of this field-based study (McMillan, 2007), so groups were not matched across any demographic variables. Due to randomisation and the participants being geographically spread across Tasmania, separation of intervention participants and control participants was varied. This was based on some participants being the only employee in their workplace, whereas other participants were one of several employees in a shared office area within their workplace. Following pre-test measures at baseline the research trial was conducted for a 13-week period, after which time POS-test measures were conducted.

Orientation session. After the initial screening, all participants attended one of three orientation sessions in a computer laboratory at Police headquarters. The purpose of the session was to discuss the procedures of the study, complete a self-report of workplace energy expenditure and blood pressure measures, and to undergo induction training for the study. The reason that all participants attended this session was that following the 13-week research period the control group was given access to the intervention for their personal use. To avoid the possibility of a surveillance effect (Sereganian, 1993) occurring in the control group, participants were informed that they would need to continue with normal workplace behaviour throughout the 13-week period of this study. The objective of continuing normal workplace behaviour was to ensure that these participants did not engage in any additional exercise or activity in relation to what they were already performing, as this could influence the results for this study.

The orientation session was conducted three times: one for the participants from the southern region of Tasmania (*n* = 31), one for participants from the north (*n* = 6), and one for the participants from the north-west (*n* = 9). All three sessions were conducted in the same week, and were coordinated by the research team. Each venue provided access to desktop computers, which allowed participants to complete an electronic self-report measure of workplace energy expenditure.

All participants were exposed to an educational lecture on the importance of workplace health for desk-based employees, divided into several segments. The first 15 minutes were spent explaining the negative health effects associated with prolonged occupational sitting time. Charts were used to emphasise research findings on cardiovascular disease mortality rates among different occupations. Based on workplace guidelines (Worksafe Australia, 1996) and recent health evidence (Hamilton, Hamilton, & Zderic, 2007; Healy et al., 2008) the participants were advised that removing themselves from a seated position once every hour could produce a positive health effect. The next ten minutes were spent describing common challenges related to changing personal habits, specifically relevant to interrupting POS, and the benefits associated with modifying this habit. The focus then shifted to the mechanism designed to modify sitting behaviour, with a ten-minute explanation and demonstration of how to perform physical activity within the workplace, and examples of how to incorporate more movement into daily tasks. The final ten minutes consisted of explicit instructions on how the workplace intervention functioned and recommendations on how to engage with it. Participants were encouraged to trial the intervention and raise any questions or concerns to enhance their learning and understanding. Typical questions were focused on implementation and use throughout the day (such as when away from the personal desk and computer), use in different work environments (i.e., during meetings, video conferences), dose and frequency of movement (i.e., number of repetitions, level of intensity), along with leave and absentee arrangements. The author of this thesis addressed these questions as the lead researcher.

All participants had their blood pressure measured during the orientation session by a registered nurse (Australian Nursing and Midwifery Accreditation Council, 2013). Established protocols for blood pressure measurement were followed to ensure quality and consistency (Heart Foundation, 2011), including time spent seated prior to and between blood pressure measurements. The participants were familiar with blood pressure measurements as they form part of the employee annual health check of TDPEM. Blood glucose, cholesterol, and triglycerides were measured by all participants visiting a pathology laboratory during weeks one and 13 of the experimental period. Details of these quantitative measures and related procedures are provided in the Instruments section of this chapter.

Following the pre-test measures and orientation session the participants assigned to the experimental group had the intervention installed on their workplace desktop computers.

The intervention: Exertime. The intervention was an interactive computer-based software program titled ‘Exertime’, designed by researchers Dean Cooley and Scott Pedersen (2009). The researchers had a shared interest in the areas of health, physical activity, movement behaviours, inclusivity, and psychology, and developed the intervention to engage populations prone to sitting in daily movement. The TDPEM Occupational Health and Safety Officer was made aware of the Exertime program by a mutual colleague who was employed by the Tasmanian Government with the Premier’s Physical Activity Council in 2009. Following this, the TDPEM Occupational Health and Safety Officer contacted the Exertime designers to discuss use and research opportunities. This software is designed to prompt employees to interrupt long bouts of sitting by standing up to engage in a brief bout of NEAT periodically during work hours. The Exertime sequence is initiated every 45 minutes, appearing as a prompt bubble on the bottom right of the computer, occupying a large part of the screen. This prompt is depicted in Figure 1.

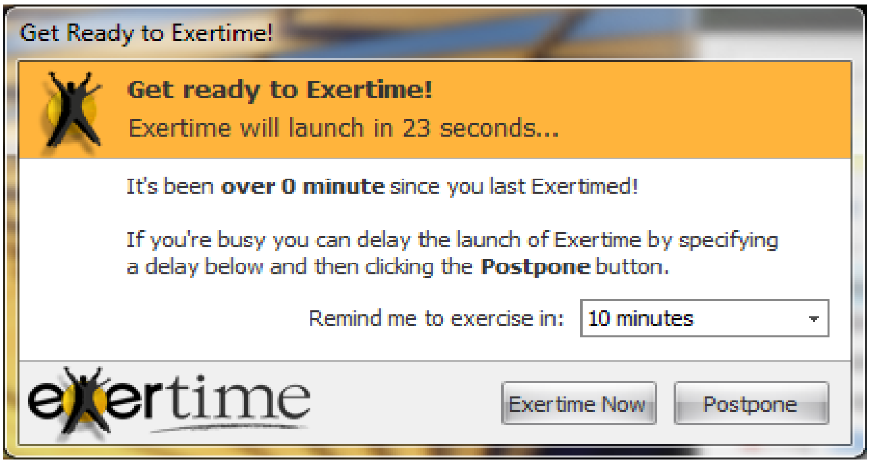

Figure 1: The Exertime prompt

The 45-minute prompt time was based on national guidelines for office employees (Worksafe Australia, 1996), which specify that all computer-based employees should remove themselves from a sedentary position for a short period every hour. The prompt indicated that it was time to stand up and engage in a user-selected Exertime activity, such as stork stands, desk push-ups, or climbing stairs. This is depicted in Figure 2. A list of the Exertime activities with brief descriptions of each exercise can be found in Appendix B.

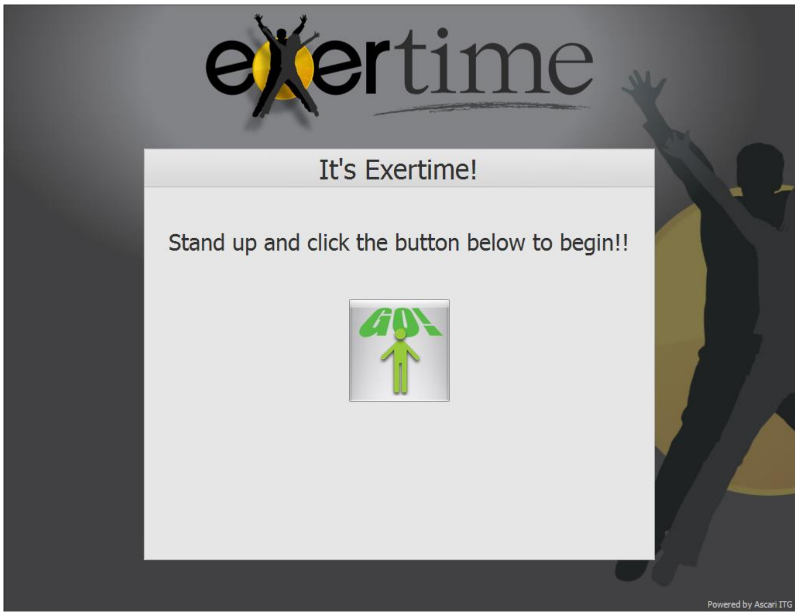

Figure 2: Stand and engage in Exertime

The prompt was passive in that the participant had no choice but to engage with it within a 30-second period. The passivity of the prompt meant that the participants had no control over the prompt appearing, and thus involuntarily engaged with the prompt without making a conscious decision (Williams, Wells, McCart, & Preusser, 2000). A 30-second countdown measure was included, during which time the participant could select *Exertime Now* and engage with the program, *postpone* and delay the prompt, or simply wait for the countdown to finish, at which time the program would automatically engage. The postpone function enabled the participant to temporarily delay the prompt for a selected time period (e.g., by 10, 15, 30, or 60 minutes) before it reappeared. This function could only be activated for a maximum time of one hour. The inclusion of a POSpone function was based on the expectation that an employee might be involved in a phone conversation, an important meeting, or might need to access computer-based information rapidly; in such a situation the employee could choose to postpone the prompt.

The frequency of daily use of the program for each participant was self-reported by the participants clicking the mouse on the ‘go’ button once prompted, and this was recorded by the software. For example, if an employee worked an eight-hour day with a one-hour lunch break and chose to engage with the prompt each hour with no postponements, then the software recorded seven Exertime engagements for that day, demonstrating full compliance. If an employee chose to postpone the prompt for an hour at some point, then the program recorded less than seven engagement times for that day.

Upon accepting the prompt to stand, the participants’ computer screens were occupied by a selection of NEAT activities; these are depicted in Figure 3. Participants could view a suite of 65 video demonstrations of NEAT activities performed in an office environment.

Figure 3: Select an exercise

Once participants selected an activity he or she decided how to engage with the prompted opportunity. There was no set requirement in terms of repetitions, activity duration or activity intensity. At the very least, he or she could simply stand to interrupt POS during the Exertime sequence. Upon activity selection participants were guided by a 30-second video of that specific activity. When participants completed the chosen activity they were prompted to record the number of repetitions or the amount of time taken in seconds, so the software could log daily progress. An optional feature of the program was that participants could choose to view a graphic representation of their progress indicating the amount of calories expended and the amount of time spent out of their chair to engage in the activity. This is shown in Figure 4. Participants were provided with the opportunity to view their progress, or could simply exit the program and return to work once the Exertime details were recorded.

Figure 4: View of my progress

Research has indicated that people who want to change their health habits should be encouraged to monitor their progress in adopting a new behaviour (Kruger, Blanck, & Gillespie, 2006; Yon, Johnson, Harvey-Berino, Gold, & Howard, 2007). Once a participants' data were recorded the Exertime sequence terminated and the employee was able to regain control of the computer screen and continue work. This is depicted in Figure 5.

Figure 5: View my progress or close and get back to work

Any occasion that employees were not sitting in their desk-based chair during work was considered interrupting POS, and the software was designed to record this progress. For example, if an employee took a break to use the toilet or walked over to speak to a colleague, this activity could be logged as ‘additional Exertime’. This feature was included to cater for intentional breaks that employees might take throughout the workday, and that are characteristic in various occupations. This additional Exertime option did not function passively and automatically appear on the computer screen periodically throughout the workday: it was an active prompt accessed by the individual user. Including this data recording feature allowed employees to register interruptions to POS that were not prompted by the intervention but contributed to NEAT and to total energy expenditure. The log additional Exertime screen icon is depicted in Figure 6.

Figure 6: Log additional Exertime

Internal validity. To improve the internal validity of this field-based study, several steps were taken. During the research period participants received a call from me to ensure that they were accurately reporting their participation in Exertime activities. Each of the 20 experimental group participants was contacted while at work between weeks four and six of the experimental period to clarify true and exact reporting of Exertime activities and confirmation that correct procedure was being followed (Appendix C). Participants were asked about participation in activities on a particular date (i.e., the day before the phone call), and the number of times particular activities were performed on this date. Participants were also asked if the data recorded for the day were accurate, and were given the opportunity to ask any questions about the intervention.

During the experimental period the control group were instructed to continue work as usual. With the design of this study involving the control group continuing workplace behaviour as they would normally, there was a possibility of surveillance (the ‘Hawthorne effect’) of the energy expenditure of the control group (Sereganian, 1993). This was particularly likely if members of the control group shared an office space with participants from the experimental group. The control group, in the orientation session, was informed that they would receive the intervention after the 13-week research period, and each member was contacted by phone during the study to clarify that they had continued workplace behaviour as usual (Appendix D). Each of the 26 control group was contacted by me between weeks four and six of the trial to confirm that they had not initiated an increase in physical activity participation since the onset of this study.

Inventory: Self-report:

Occupational Physical Activity Questionnaire (OPAQ). Energy expenditure value was determined by participants reporting the amount of time per week in hours spent in three separate categories; sitting/standing, walking, and performing heavy labour while at work. For each category a metabolic equivalent (MET) score was calculated using the employee’s body weight, amount of work hours per week spent in each category, and a constant MET value coefficient for each particular category (sitting/standing: 1.2 METs, walking: 3.0 METs, heavy labour: 7.0 METs). A MET is the ratio of the associated metabolic rate for a specific activity divided by the resting metabolic rate. Each category MET value was then divided by 1000 (to convert to litres), multiplied by 21 (to convert to joules), and divided by 4.2 to reach a caloric value (Powers & Howley, 1997). The number of hours spent in each category was totalled and represented a total activity value per week. The sum score of the sitting/standing, walking, and heavy labour category MET values is the dependent variable for this inventory (Pedersen et al., 2014). The OPAQ inventory is presented in Appendix E.

Quantitative Measures: Physiological Biomarkers

Blood pressure. To establish if the intervention used in this study influenced the participants' blood pressure levels, a qualified nurse recorded participant resting systolic and diastolic blood pressure during the pre-test and post-test periods. The appointment of a qualified nurse for blood pressure tests was based upon the nurse meeting all five criteria established by the framework for the assessment of internationally qualified nurses and midwives for registration (Australian Nursing and Midwifery Accreditation Council, 2013). The instrument used to measure blood pressure was a Welch Allyn Sphygmomanometer Platinum Series DS58-11, in which an inflatable cuff placed around the upper arm records systolic and diastolic pressure in millimetres of mercury (mmHg). Participants were informed by the researcher that blood pressure measurements would be taken four weeks prior to the orientation session, between 8:00 and 9:00 am before the commencement of work duties. This procedure was adopted to limit the amount of time participants had to perform any movement that could possibly influence blood pressure, and so they could maintain their regular work routines. All participants underwent two consecutive blood pressure measurements with a one-minute interval between each. Participants were instructed to remain seated while the measurement was taking place, and each participant was seated for a minimum of five minutes before each reading was taken (Vidt et al., 2010). These guidelines were followed to ensure quality and consistency (Heart Foundation, 2011).

Previous research has stipulated that POS can contribute to elevated levels of blood pressure (Pouliou, Myung, Law, Li, & Power, 2011). To obtain a total measure of blood pressure, the dependent variable measured in this study was mean arterial pressure (MAP). MAP is defined as the average pressure throughout the cardiac cycle (Oblouck, 1987). MAP has physiologic and clinical importance since it represents the arterial pressure during both the systolic and diastolic phases of the cardiac cycle. MAP is calculated by blood pressure cuff measurements using the formula that equates to one third of the distance between the systolic pressure and the diastolic pressure (Cywinski, 1980; Ira, 1996). Measurements for MAP that are greater than 110 mmHg in adults are considered too high and can impact negatively on health (Seeley, Stephens, & Tate, 1995). In a study examining cardiovascular disease in 11 150 men aged between 40 and 84 (Sesso, Paffenbarger, & Lee, 2000) MAP was strongly associated with increased cardiovascular disease in men 60 years and under. To quantitatively measure if the intervention influenced the blood pressure of the participants in this study, the physiological biomarker MAP was recorded at pre-test and post-test (Mainsbridge, Cooley, Fraser, & Pedersen, 2014).

Blood glucose, cholesterol and triglycerides. Myers (2003) suggested that POS can lead to adverse physiologic profiles including elevated values of blood glucose, and adverse blood lipid profiles such as elevated cholesterol and triglycerides. To measure blood glucose, cholesterol and triglyceride levels, each participant visited a certified phlebotomist in a pathology laboratory during the first week (pre-test) and final week (post-test) of the research period. A fasting procedure was adopted because if a participant is not fasted it is possible that some blood test values may change following the digestion of food (Seeley et al., 1995); for example, digesting food or drink that is high in sugar will increase blood sugar levels. Fasting overnight also allows for a morning test base result to be developed, and that can be compared over time Blood glucose was measured by collecting a sample of blood and placing the sample in blood clot tubes, where a process of serum chemistry permitted the metabolism of glucose in the blood cells until it was separated by centrifugation (Ascaso et al., 2003). Normal range for a blood glucose measurement following overnight fasting is between four and six mmol/L (Diabetes Australia, 2008).

Cholesterol was measured by mixing the collected plasma with chemical re-agents, including cholesterol ester hydrolyase, cholesterol oxidase, peroxidase and a chromogen. A reaction resulted in a red coloured product, measured using a spectrophotometer to provide a reading of the cholesterol concentration in the sample (Cox & Garcia-Palmieri, 1990). Total cholesterol (combination of LDL and HDL cholesterol) at a desirable level is classified as 5.2 mmol/L; 5.2 to 6.2 mmol/L is borderline high and above 6.2 mmol/L is high (Ballantyne, Blazing, King, Brady, & Palmisano, 2004).The measurement of total cholesterol was recorded in this study, as both LDL and HDL levels provide an indication of individual health level relevant to cardiovascular disease and premature death (Ballantyne et al., 2004).

Triglycerides were measured with a re-agent comprising the enzymes lipase, glycerol kinase, glycerol phosphate oxidase and peroxidase, together with adenosine triphosphate and a chromogen. A reaction resulted in a red coloured product, which was measured with a spectrophotometer to determine triglyceride levels (Cox & Garcia-Palmieri, 1990). A spectrophotometer identifies materials and measure properties of light over a specific portion of the electromagnetic spectrum. The electromagnetic spectrum is the range of all possible frequencies of electromagnetic radiation (Freeman & Knox, 1964). The American National Cholesterol Education Program Adult Treatment Panel guidelines indicate that a normal triglyceride level is <150 mg/dL (Ford, Giles, & Dietz, 2002). Unhealthy triglyceride levels are recognised as levels >500mg/dL, with levels >1000mg/dL becoming clinically significant (Athryos et al., 2002; DiMagno & Chari, 2002).

Data Analysis

Descriptive statistics were reported in tabular form as means and standard deviations for each of the dependent variables measuring health. The OPAQ categories and the resultant MET calculations were reported for both groups across time. Overall reliability for this self-report measure was reported using Cronbach's alpha coefficient (α). Intra-class correlation coefficients and 95% confidence intervals were calculated for the mean values of each of the dependent variables between pre-test and post-test.

Two (Group: Experimental/Control) X two (Test: Pre-test/post-test) mixed design ANOVAs were used to determine any significant differences in the five dependent variables (METS, MAP, glucose, cholesterol, triglycerides), separately. Alpha levels were set a priori at 0.05 with a modified Bonferroni technique to correct for any violations against Type I error caused by multiple comparisons. Any significant interactions were further examined using simple main effects analyses. Cohen's *d* statistic was used to calculate the effect size for both groups between pre-test and post-test. These data were analysed using PASW version 18.0 (SPSS Inc., 2009).

Results

Cronbach's alpha statistic ($\alpha = 0.61$) indicated 'questionable' reliability of the collapsed group pre-test and post-test OPAQ responses (George & Mallery, 2003). This 'questionable' finding may have been related to a lack of sensitivity caused by the original OPAQ categories and subsequent MET values, in particular the combination of sitting and standing behaviours within one question/response. This will be elaborated on further in the discussion.

The ANOVA results revealed a significant interaction between group and test occasion, $F(1,44) = 4.20$, $p < 0.05$, such that the experimental group increased their MET per hour values from pre-test (*M* = 106. 57 +/- 35.13) to post-test (*M* = 119. 25 +/-

38.15) with a medium effect size of Cohen's *d* = 0.35, whereas the control group decreased their MET per hour values from pre-test (*M* = 124. 75 +/- 54.94) to post-test (*M* = 109. 81 +/- 42.20) with a medium effect size of Cohen's *d* = 0.31. When separated by group, follow-up simple main effect pre-test to post-test comparisons did not reach significance for the experimental group (F [1,44] = 3.43, p = 0.07), and for the control group (F[1,44] = 1. 01, p = 0.32). Likewise, there were no significant differences for either main effect. Descriptive statistics for each group by test, and intraclass reliability results for the OPAQ categories are presented in Table 2.

Table 2

Descriptive statistics are the hours per week values reported for the separate OPAQ categories as a function of group and test. Values are presented as means (*standard deviations*)

	Experimental (n = 20)		Control (n = 26)		Total (N = 46)	
OPAQ responses	Pre	Post	Pre	Post	ICC	95% CI
Work hours	39.89 (*5.68*)	40.14 (*9.27*)	43.98 (*19.15*)	42.45 (*10.11*)	0.65	0.25, 0.88
Sit/Stand hours	33.00 (*7.35*)	32.53 (*4.44*)	35.21 (*6.34*)	34.09 (*4.98*)	0.47	0.05, 0.77
Walk hours	4.92 (4.*82*)	7.22 (*5.29*)	4.88 (*4.74*)	4.03 (*4.20*)	0.43	0.13, 0.75
Heavy labour hours	0.00 (0.00)	0.00 (0.00)	0.21 (0.00)	0.19 (0.00)	0.07	0.00, 0.53
METs	106.57 (*35.13*)	119.25 (*38.15*)	124.75 (*55.67*)	109.81 (*43.01*)	0.60	0.28, 0.78

Exposure to the intervention resulted in the experimental group participants interrupting POS and standing an additional 7.99 ± 4.44 minutes by engaging in short bouts of NEAT activities 6.28 ± 3.59 times per workday, for a duration of 1.34 ± 0.74 minutes of work time for each endeavour.

Physiological biomarkers

Descriptive statistics for each group by test, and intraclass reliability results for Mean Arterial Pressure (MAP), are presented in Table 3.

Table 3

Descriptive statistics are the values reported for MAP as a function of group and test. Values are presented as means (*standard deviations*)

	Experimental (*n* = 9)	Control (*n* = 18)	Total (*N* = 27)	
			ICC	95% CI
Pre-test	105.77 (*8.84*)	101.98 (*16.60*)	0.04	0.14, 0.17
Post-test	96.30 (*6.55*)	102.07 (*10.61*)	0.13	0.37, 0.59

The ANOVA results revealed a significant interaction between group and test occasion, $F(1,26) = 5.06$, $p < 0.05$, such that the experimental group decreased MAP from pre-test (*M* = 105. 77 +/- 8.84) to post-test (*M* = 96.30 +/- 6.55) with a medium effect size of Cohen's *d* = 0.52, whereas the control group decreased MAP from pre-test (*M* = 101. 98 +/- 16.60) to post-test (*M* = 102. 07 +/- 10.61) with a small effect size of Cohen's *d* = 0.03. Follow-up analysis using Tukey's HSD revealed a significant difference between the mean values for the experimental group, but there was no significant difference between the mean values for the control group.

For the experimental group, mean systolic pressure was 132 (*15.38*) and mean diastolic pressure 85.27 (*11.13*) at pre-test. At post-test mean systolic pressure was 127.72 (*8.25)* and mean diastolic pressure 79 (*7.88*). For the control group, mean systolic pressure was 137.17 (*17.91*) and mean diastolic pressure 84.39 (*14.88*) at pre-test. At post-test mean systolic pressure was 135.89 (*17.28)* and mean diastolic pressure 85.17

(*11.73*). Descriptive statistics for each group by test, and intraclass reliability results for blood glucose, are presented in Table 4.

Table 4

Descriptive statistics are the values reported for Blood Glucose as a function of group and test. Values are presented as means (*standard deviations*)

	Experimental (n = 11)	Control (n = 18)	Total (N = 29)	
			ICC	95% CI
Pre-test	4.41 (*0.27*)	4.81 (*1.28*)	0.07	0.56, 0.74
Post-test	4.42 (*0.46*)	4.94 (*1.69*)	0.02	0.19, 0.23

The ANOVA results revealed no significant differences for blood glucose between pre-test and post-test in either the experimental or control group $F(1,28) = 0.79$, $p < 0.05$. An incremental increase occurred for the control group between pre-test and post-test. Descriptive statistics for each group by test, and intraclass reliability results for cholesterol, are presented in Table 5.

Table 5

Descriptive statistics are the values reported for Cholesterol as a function of group and test. Values are presented as means (*standard deviations*)

	Experimental (n = 11)	Control (n = 18)	Total (N = 29)	
			ICC	95% CI
Pre-test	5.15 (*0.90*)	5.38 (*1.32*)	.01	0.26, 0.45
Post-test	5.14 (*0.91*)	5.49 (*1.43*)	.00	0.09, 0.15

The ANOVA results revealed no significant differences for cholesterol between pre-test and post-test in both the experimental group and control group $F(1,28) = .855$, p

< 0.05. An incremental increase occurred for the control group between pre-test and post-test. Descriptive statistics for each group by test, and intraclass reliability results for triglycerides, are presented in Table 6.

Table 6

Descriptive statistics are the values reported for Triglycerides as a function of group and test. Values are presented as means (*standard deviations*)

	Experimental (n = 11)	Control (n = 18)	Total (N = 29)	
			ICC	95% CI
Pre-test	1.26 (0.57)	1.24 (0.73)	.007	0.18, 0.24
Post-test	1.24 (0.80)	1.25 (0.60)	.023	0.51, 0.77

The ANOVA results revealed no significant differences for triglycerides between pre-test and post-test in either the experimental or control group $F(1,28) = .802$, $p < 0.05$. Incremental changes for both groups occurred between pre-test and post-test.

Discussion

The aim of Study A was to evaluate if interrupting POS and increasing short bouts of NEAT was an efficacious mechanism by which to improve the health of a cohort of desk-based employees. In this study health was defined by three independent mechanisms: self-reported perceptions of workplace energy expenditure (OPAQ) (Reis et al., 2005), blood pressure measurements, and blood measures for glucose, cholesterol, and triglycerides. The results for the dependent variable mean arterial pressure (MAP) indicate support for Research Hypothesis 2, in that a workplace intervention designed to interrupt prolonged occupational sitting can improve the health of desk-based employees. Results from the ANOVA revealed that the experimental group who were exposed to the intervention significantly decreased their MAP when compared to a control group, over a 13-week period. This finding provides support for Healy et al. (2008), who found that frequent breaks in sedentary time improve cardio-metabolic profile when compared with uninterrupted sedentary time, independent of moderate-to-vigorous physical activity. The control group did not receive the intervention; however, their ANOVA results for MAP increased between pre-test and post-test. Lowering MAP in adults by interrupting POS is an important health outcome for workplaces because high MAP levels are related to increased risks of morbidity and mortality (Grossman, 2011). As previously acknowledged by Seeley et al. (1995), measurements for MAP that are greater than 110 mmHg in adults are considered too high and can have an adverse impact on individual health. In individuals with hypertension (greater than 140/90 mmHg; MAP greater than 107), the initial goal of treatment is to reduce MAP to a normotensive pressure (Smithburger, Kane-Gill, Nestor, and Seybert, 2010). Typically hypertension is treated with prescribed medication and continuous physical activity.

The analysis of MAP was constructed on the basis of evidence indicating an association between MAP and cardiovascular disease risk factors (Dyer et al., 1982; Mitchell et al., 1997). To date no other studies have measured MAP in relation to POS. Specifically, within the literature there is scant evidence to insinuate that POS affects blood pressure, or that short bouts of NEAT decrease blood pressure; nevertheless, substantial evidence does exist to validate the benefit of regular doses of continuous physical activity and exercise on blood pressure, such as 30 minutes of physical activity on five days each week (Bouchard et el., 2007; Fletcher et al., 1996; Warburton et el., 2006). In this study the addition of interrupting POS and performing NEAT in the workplace increased energy expenditure and subsequently intensified a series of physiological processes that impacted on MAP (Hill, Wyatt, & Peters, 2012): that is, targeting NEAT rather than long-duration continuous physical activity yielded a favourable response on the MAP of the participants in the experimental group. Over the research period the heart and associated physiological processes adapted to the daily standing and short bouts of NEAT and became more efficient, and therefore MAP decreased. The intervention used in this study provides support for the benefit of interrupting POS in desk-based employees, with its positive effect on employee health (Chau et al., 2013; Healy et al., 2013; Matthews et al., 2012; Pronk et al., 2012; Stamatakis et al., 2013; Wilmot et al., 2012). Furthermore, the reduction in MAP suggests that not specifying physical activity duration and intensity, but instead targeting NEAT activities, may be an effective method for improving cardio-metabolic measures in desk-based employees.

Previous research has identified a strong relationship between blood pressure and cardiovascular disease, and all-cause mortality (Stamler, Stamler, & Neaton, 1993), with physical inactivity being strongly positively associated with hypertension (Wareham et al., 2000). This background information emphasises that many workplace environments contribute to physical inactivity, which places employees at increased risk of a cardiovascular event such as hypertension (Chobanian et al., 2003). Based on this evidence, physical activity is widely advocated in the treatment of hypertension (Rice et al., 2002); yet for many workers a minimum of 30 minutes of continuous physical activity during the workday is neither realistic nor feasible. The findings from this study show that modifying POS behaviour and incorporating short bouts of NEAT periodically throughout the workday can produce favourable results for MAP without substantial time and effort. With modern day workplace administrators and managers being highly focused on work productivity and functioning economically, often at the expense of health (McGillivray, 2002), the intervention used in this study presents a possible solution to improving cardiovascular health without taking significant time out of the workday. In addition, the reduction in MAP suggests that high intensity 'huff and puff' exercise is not the only method to lower blood pressure. This is supported by research which has proposed that low intensity exercise may be more effective in lowering blood pressure than high intensity exercise (Hagberg et al., 1989; Motoyama et al., 1998; Rogers et al., 1966). Thus, the significant decrease in MAP reported in this study dispels several long-held beliefs about how blood pressure can be reduced to benefit health in a sedentary population.

The reported decrease in MAP suggests that interrupting POS might provide health benefits supplementary to those gained from 30 minutes of moderate-to-vigorous physical activity. Notwithstanding well documented reports of the health benefits associated with meeting recommended physical activity guidelines (Blair, LaMonte, & Nichaman, 2004; Warburton et al., 2006), the findings from this study indicate a need for greater focus on how individuals spend their time when they are not performing volitional sport-like exercise or sleeping. According to Hamilton, Healy, Dunstan, Zderic, & Owen (2008), what actually happens during non-exercise time may be as important as that of volitional exercise. The work of Pate et al. (2008) illustrated that daily energy expended primarily through light-intensity activity can be greater than the energy expended daily in a continuous bout of physical activity that meets guidelines. The decrease in MAP found in this study provides support for increasing energy expenditure by interrupting POS and performing short bouts of NEAT, demonstrating that it is possible to institute health benefits in other ways than following physical activity guidelines. This finding provides further strength for the endorsement of guidelines and recommendations for limiting sedentary behaviour as highlighted by Buckley et al. (2015), Dunstan et al. (2010), Healy et al. (2012), Owen et al. (2010), and Thorp et al. (2009). To gain increased health benefits, interrupting POS and performing short bouts of NEAT every hour in environments where sitting is customary, in addition to meeting nationally recommended guidelines, is advocated.

Occupational physical activity. It is plausible that the observed decrease in MAP could be attributed to the increase in energy expenditure self-reported by the participants. Results from this study indicated support for Research Hypothesis 1, that a workplace intervention designed to interrupt prolonged occupational sitting can improve the health of desk-based employees. Results from the ANOVA revealed that the experimental group increased MET expenditure between pre-test and post-test, whereas the control group decreased MET expenditure over the course of the experimental period. This explanation should be interpreted with caution, given the low participant numbers in the study. For example, although a significant interaction was found between group and test for OPAQ (Reis et al., 2005), there was insufficient power to produce significant follow-up simple main effects when separated by group.

The most noticeable change in energy expenditure for the experimental group was in the amount of time spent performing short bouts of NEAT. Through exposure to the intervention, experimental group participants introduced NEAT activities such as taking a walk, stair climbing, wall sits, desk push ups, step ups and squats into the workday. Moreover, experimental group participants were exposed to the intervention on a regular basis while at work, and the increase in self-reported energy expenditure suggests that NEAT activities were executed on a regular basis. This is confirmed by the results of the analysis, which demonstrate that time spent walking increased by over two hours per week, with total activity increasing just less than two hours per week. The intervention in the current study challenged employees within a typical workplace environment to interrupt sitting rather than promote it. To enable the experimental group to achieve an increase in energy expenditure, interrupting POS was the initial stimulus and key to engaging participants in workplace NEAT. Participants exposed to the intervention interrupted POS and increased energy expenditure, and thus possibly gained health benefits while at work.

One possible explanation for this rise in NEAT and the resultant energy expenditure is the passive nature of the prompt that featured in the intervention, and the approach which engaged the participants unconsciously to change their health behaviour at work. By removing the cognitive decision-making and voluntary process of standing from the chair and performing NEAT, the passive prompt stimulated participants to interact with the workplace environment in a manner unlike anything in the past: that is, participants were both interrupting POS and moving in the workplace, two behaviours which prior to exposure to the intervention occurred seldom. Through not being afforded the opportunity to cognitively and consciously process the merits of whether to get out of the chair or not, the selected behaviour of deciding to stand was already provided (Forster, 1982). The passivity of the prompt provided a reminder or nudge that indicated that the participants had been sitting for an excessive period (Worksafe Australia, 1996), with the ensuing act leading to active behaviour. This process supported an increase in energy expenditure, and contributed to improving the health of the desk-based participants.

According to Gielen and Sleet (2003) a passive approach to health relies on changing products or environments to make them more accessible and safer. Individual desktop computers were the mechanism by which health behaviour change was directed, to improve the health of the participants. The reasoning was that individuals interacted and engaged with computers for the vast majority of their tasks, commonly while seated (Aarts & Dijksterhuis, 2000; Ouellette & Wood, 1998). By embedding the intervention and passive prompt feature into the work computers of the participants, health behaviour was impacted by manipulating the computer platform that participants engaged with, consequently interrupting the POS habit. This change made standing and performing NEAT in the workplace more accessible (Gielen & Sleet, 2003; Neuhaus et al., 2014), and altered how participants perceived and interacted with the workplace environment at an individual level. According to Bronfenbrenner’s (1992) social ecological model this aligns with the microsystem and mesosystem levels with experimental group participants beginning to view the office environment as a setting where movement may be performed, rather than where it is hindered. The passive prompt appears to be an effective mechanism for overcoming the barrier of interrupting POS, increasing energy expenditure and promoting health in the workplace.

At an individual level, two elements of Study A may have been instrumental in participants’ perceptions of energy expenditure between pre-test and post-test. First was the inclusion of an education component on the adverse health effects of POS and appropriate workplace movement in the orientation session. Previous research has shown that point-of choice prompting to reduce sitting time, plus education, is superior to education alone in reducing long uninterrupted periods of sitting at work (Evans et al., 2012). It is conceivable that prior to the education session participants had limited knowledge of the adverse health effects associated with POS, did not realise how much time at work was spent sitting, and were unaware of any need to interrupt POS. The education component of the orientation session could have surprised participants and provided them with new health knowledge, giving them a stimulus and motivation to change their workplace health behaviour. Control group participants were also exposed to the education component, and they did report a reduction in POST between pre-test and post-test, although time spent walking and total physical activity decreased. Second, the intervention operated on individual user control. Griffiths, Lindenmeyer, Powell, Lowe, and Thorogood (2006), Kreps and Neuhauser (2010), and Neuhaus et al. (2014) all found that positive outcomes such as engagement with and adherence to computer-controlled health interventions included enhanced user control. In this study, once the user was passively prompted to stand, he or she took control of which activity to perform, the level of intensity at which to perform it, and the duration for which the activity would be executed. The combination of being passively prompted involuntarily but then voluntarily determining how to engage with the activities had a favourable impact on workplace movement. This control and level of engagement could have contributed to participants developing a routine with the activities they selected and performed, the number of repetitions performed, and the time devoted to execution.

Another factor that could have influenced participants' health behaviour was the 13-week time frame. This allowed sufficient time for the experimental group to establish routines in response to the intervention, as was found in previous health behaviour research (Lally et al., 2010). Several other studies have investigated the impact of health interventions to change behaviour, but tested the interventions for short periods, between four (Leslie et al., 2005) and eight weeks (Napolitano et al., 2003; Pressler et al., 2010). The reported reduction in sitting time and increase in energy expenditure reported suggests that the regularity with which active behaviour is performed daily contributes to interrupting the POS habit, and establishes standing and NEAT as replacement behaviours. Ultimately, the research time frame encouraged the development of a health habit through regular and frequent prompting, compelling participants to increase energy expenditure while at work.

The intent of the intervention used in this study was to compel employees to sit less during working hours, and to stand and move more. The third question of the OPAQ does not distinguish between sitting and standing, and uses a 1.2 MET constant value for calculating workplace energy expenditure that combines these two postures into one category. This shortcoming has been noted by Pedersen et al. (2014). In the *Compendium of Physical Activities* (Ainsworth et al., 2000) MET intensities for sitting range from 1.0 (sitting quietly and watching television) to 2.5 (sitting and operating a forklift or crane at moderate intensity); values for standing range from 1.8 (standing and reading or talking on the phone) to 3.5 (standing and partaking in moderate intensity arts and crafts). Clearly, sitting and standing MET values are not the same. Levine, Melanson, Westerterp, and Hill (2001) provided evidence to substantiate this difference by reporting that non-obese volunteers expended 50 per cent more calories when standing than when sitting. Dividing these two distinct behaviours into separate categories and using separate MET values might have provided a more sensitive measure of the amount of energy expenditure in the workplace. Recently Chau, van der Ploeg, Dunn, Kurko, and Bauman, (2012) developed the Occupational Sitting Physical Activity Questionnaire (OSPAQ), which separates standing and sitting behaviours with adjusted MET values. Although this inventory was not available during data collection for this study, future use of the OSPAQ is recommended because it splits unhealthy sitting behaviours and healthier standing behaviours into separate categories to provide a more accurate measure of workplace energy expenditure, and to better assess the effectiveness of interventions designed to reduce workplace sitting.

Previous studies have investigated employee sitting behaviour and movement throughout the workday, using objective measures such as accelerometers (Owen et al., 2010; Parry & Straker, 2013). Despite the increased use of accelerometers for objective measures, issues in the use of accelerometry for the assessment of sitting behaviour relate to device initialisation, post-processing, and signal feature extraction, (Corder, Ekelund, Steele, Wareham, & Brage, 2008). Limitations of accelerometers as a measure of sitting is that they assess intensity of movement and therefore are not always able to distinguish between postures such as sitting or lying, or standing still (Atkin et al., 2012, Jannsen, Twisk, Toussaint, van Mechelen, & Verhagen, 2013); upper body movement is not always detected as these devices are placed around the waist. Notwithstanding the increasing popularity of objective measures to assess sedentary behaviour and physical activity, and associated energy expenditure, several studies have typically used subjective measures to assess these (Blair & Brodney, 1999; Bryant, Lucove, Evenson, & Marshall, 2007; Clark et al., 2011; S. Marshall & Ramirez, 2011). According to Castillo-Retamal and Hinckson (2011), subjective measures are the most common in gathering data about behaviours under study because more information can be collected, with surveys the most frequent tool used to determine sedentary behaviour and physical activity. In the workplace self-report techniques such as surveys do not disrupt work flow, permit access to large samples, require only short periods of time to complete (Mummery, Schofield, Steele, Eakin, & Brown, 2005), are cost effective, and have a relatively low participant burden (Atkin et al., 2012). Against this background, and also because the participants in this study were geographically spread around the state of Tasmania, it was decided that workplace energy expenditure would be measured using validated surveys.

Blood glucose, cholesterol and triglycerides. The results for the dependent variables blood glucose, cholesterol and triglycerides from this study did not support Research Hypothesis 3, that a workplace intervention designed to interrupt prolonged occupational sitting can improve the health of desk-based employees. Statistical analysis using ANOVA showed that the experimental group reported minimal changes in each of the variable measures between pre-test and post-test. This indicated that interrupting POS and increasing NEAT over a 13-week period did not affect blood glucose, cholesterol or triglyceride levels in desk-based workers. Blood glucose and cholesterol increased between pre-test and post-test for the control group, with a minimal change in triglyceride level. These findings suggest that not interrupting periods of POS might contribute to increases in blood glucose and cholesterol in desk-based employees.

The literature concerning sedentary behaviour and physical activity provides evidence to suggest that prolonged sitting negatively impacts physiological biomarkers such as blood glucose, cholesterol, and triglycerides. Healy et al. (2012) found that behaviours involving sitting or low energy expenditure are linked with unhealthy blood glucose levels and blood lipid profiles, and with premature death from heart disease. Healy et al. (2011) and Henson et al. (2013) both found detrimental associations between sedentary time and insulin, cholesterol and triglycerides in their respective cohorts of 4757 and 878 adults, independent of moderate-to-vigorous physical activity. In contrast to these findings, research examining breaks in sedentary time has shown beneficial associations with metabolic biomarkers (Healy et al., 2008). Specifically, Healy et al. found that increasing the number of breaks in sedentary time was beneficially associated with two-hour plasma glucose and triglycerides in 168 adults. The findings from this study do not support this, instead suggesting that interrupting POS and performing NEAT does not influence the blood glucose, cholesterol, or triglyceride levels of participants. In this study the favourable results reported from interrupting POS related to the variables energy expenditure and MAP were not replicated for blood glucose, cholesterol or triglycerides.

There are several possible reasons why there was little movement in blood glucose, cholesterol, and triglyceride measures between pre-test and post-test. First, small participant numbers (N = 29) could have limited the range of the statistical analysis and its subsequent statistical power. According to Hong and Park (2012), a small sample size increases the difficulty of detecting true evidence for an association, and increases false negative rates such as reduced statistical power. Although the sample in Study A included 46 participants, requesting that participants visit a pathology laboratory independently proved problematic, and became a methodological limitation for this study, with 17 participants not able to report results for these measures. Missing such a large amount of data from the sample affected the statistical power of the blood glucose, cholesterol, and triglycerides measures, and decreased the ability to predict causation between the variables from pre-test to post-test (Hong & Park, 2012). Most notably, the lack of data available for these variables indicates that employing such a method with participants while at work is not optimal.

The small range of results reported for each of the blood glucose, cholesterol, and triglycerides variables could have made it harder to reach 0.05 statistical significance. For instance, from the sample (N = 29) the range for blood glucose measures was 3.7 – 5.7 mmol/l, for cholesterol was 3.88 – 7.05 mmol/l, and for triglycerides was 0.6 – 2.68 mmol/l. With the small range of results reported for each of these variables it is possible that the relationship between the statistical power and the veracity of the findings is underappreciated. Moreover, due to small sample size and data range, low statistical power may have negatively affected the likelihood that a nominally statistically significant finding could be found (Button et al., 2013). Based on these statistical limitations, it is recommended that a larger sample size be used for establishing measurements of power and effect for the blood glucose, cholesterol, and triglycerides variables.

Another explanation for the absence of movement in these three measures from pre-test to post-test may have been interruptions to POS and the performance of NEAT throughout the workday. Although the intervention effectively improved energy expenditure and MAP, it could be that standing and performing short bouts of NEAT did not incur any physiological effect on these biomarkers. Findings from this study are that standing from a seated position every hour and moving for one to two minutes at any intensity does not produce favourable associations with these measures. It is possible that POS was not interrupted often enough, that the short bouts of NEAT were not performed for long enough, or that the intensity of the NEAT performed was not high enough. Recent research conducted by Duvivier et al. (2013) found that reducing sitting by increasing time spent standing and walking was more effective than one hour of vigorous exercise for improving insulin level and plasma lipids in 18 healthy female and male subjects; thus, it may be that the interruptions to POS exhibited in the current study needed to be sustained for longer to affect blood glucose, cholesterol, and triglycerides in desk-based participants. Finally, the 13-week experimental period may not have been sufficient time to establish a physiological effect on the biomarkers, and that more time is required.

Study limitations. A discussion of the limitations of this study is warranted to caution the reader against interpreting the findings of the experimental procedures described here as relevant to occupational physical activity. The occupational physical activity data collected were based on self-reports of energy expenditure at work. Dunstan et al. (2012) have initiated accelerometer research in this area, but as this research was the first investigation into the intervention experimental treatment, it was considered that a field-based measurement would be less intrusive (Sereganian, 1993). While the effect size of this treatment was acceptable (Durlak, 2009), it is quite possible that this limitation decreased the power of the findings and caused the subsequent lack of significance in simple main effects analysis of the experimental treatment (p = 0.07).

With regard to the physiological biomarkers measured, the most notable limitation was the small sample sizes. Contributing to the small sample size for blood pressure measurements recorded post-test was the fact that several participants were on leave or unwell, and consequently were not retested. This identified a methodological issue, with the objective measurement of this variable and with the study design. The possibility that MAP could change as a result of age did exist. This is based on evidence which indicates that hypertension becomes more prevalent as people get older (Elliott, 2004; Ooi, Barrett, Hossain, Kelley-Gagnon & Lipsitz, 1997). Considering that the average age of the participants in this study was over 40 years, MAP results could have been higher than in the average Tasmanian adult population at pre-test.

A methodological issue related to the marker variables was the requirement that all participants were visit a pathology laboratory independently to have the measurements taken. Expecting the participants to do this during work hours proved to be unreasonable and unrealistic, and resulted in a substantial number of participants not reporting post-test results. The limitations identified relevant to this field-based study are typical of field-based research (Kjeldskov, Skov, Als, & Hoegh, 2004; Sun & May, 2013), with the collection of data using objective measures proving challenging, and affecting the power of the statistical analysis. A consequence of the missing data and subsequent low power calculation does limit the capacity to draw conclusions from the physiological data that are representative of the general population.

Future research. Although it was not measured as a variable in this thesis, it is possible that periodically interrupting POS and performing short bouts of NEAT had an impact on participant stress. Studies have shown increases in blood pressure in participants with high work stress (Light, Turner, & Hinderliter, 1992; Schnall et al., 1992; 1998). With widespread evidence indicating that many populations of desk-based employees spend 75 per cent of their workday seated, it is plausible that many individuals seldom interrupt their POS at work. A probable reason for not standing and moving could be the amount of work that desk-based employees have to complete, combined with the perception that time away from the workstation is not productive; collectively these two factors might influence the stress levels of desk-based employees, causing spikes in blood pressure (Light, Turner, & Hinderliter, 1992; Schnall, Schwartz, Landsbergis, Warren, & Pickering, 1992; 1998). By removing periods of POS and incorporating short bouts of NEAT, participants in this study were temporarily distracted from their tasks and were afforded a mental break. The increase in workplace movement and the mental shift from desk-based work may have contributed to a decrease in stress levels, and MAP declined accordingly. The regularity with which POS was interrupted and activity performed may also have affected stress levels, resulting in a reduction in MAP of over 10mmHg between pre-test and post-test.

Future research into increasing energy expenditure in populations who are primarily sedentary might examine the use of interventions that contain a passive prompt, or that function passively. Changing how sedentary populations interact with a physical environment that they inhabit frequently, and how these interactions influence health behaviour, is also of interest. Examples of this are populations who drive automobiles for long periods, such as bus, taxi and truck drivers, or a judge who sits in court for most of the workday. In terms of measuring physical activity and related energy expenditure using self-report measures, separating sitting, standing, and walking behaviours is recommended to obtain a more accurate measure of specific categories of sedentary and physical activity behaviour. In occupational settings the use of the OSPAQ (Chau et al., 2012) to split unhealthy sitting behaviours from healthier standing behaviours, and the subsequent depiction of category MET values for each behaviour is suggested. An implication for many workplaces may be a perception by managers and administrators that desk-based employees should remain seated at their workstations while at work, and that time spent away from this position is unproductive; consequently, if a desk-based employee periodically interrupts their POS and undergoes brief bouts of NEAT, this could be viewed as time wasting and contradictory to completing tasks. Measuring the impact of a workplace intervention to reduce sitting and increase energy expenditure on work productivity is a field that to date has received little investigation.

Prospective research examining the physiological outcomes of interrupting POS and increasing NEAT could consider comparing regularly interruptions to sitting with short bouts of movement against a single interruption with one long continuous bout of activity. A plethora of evidence advocates the benefits of continuous physical activity and exercise on cardiovascular and metabolic health (Blair, 2010; Fletcher et al., 1996; Warburton et al., 2006); measuring the efficacy of regular short bouts of NEAT throughout the day on cardiovascular and metabolic health could reap similar findings. Given the significant finding with MAP in this study, this warrants further investigation. Previous studies have shown that stress can adversely affect blood pressure, with work-related stress a commonly reported form (Meurs & Perrewe, 2011; Michie, 2002). Testing the effect on stress of regularly interrupting sedentary populations and performing short bouts of NEAT is a relatively unexplored area. Considering the relationship between blood pressure and stress, the prospect of interrupting POS and introducing short bouts of NEAT offers potential to impact on levels of individual stress within different environments.

Rationale for Study B

The findings from Study A indicate that the intervention was effective in improving MAP and increasing occupational physical activity in participants, thus demonstrating its capacity to improve the health of desk-based employees. Despite these positive findings, the lack of change in the results for blood glucose, cholesterol, and triglycerides between pre-test and post-test raised some concern for me in relation to the ability of the intervention to influence health. This concern emerged from the documented evidence in the literature identifying the adverse health effects of sitting behaviour on blood glucose (Dunstan et al., 2004), metabolic syndrome (Dunstan et al., 2005; Hamilton, Hamilton, & Zderic, 2007; Hamilton et al., 2008), mortality (Dunstan et al., 2010; Katzmarzyk, 2010), and cardiovascular health (Healy et al., 2011; Thorp et al., 2012). Although there is some evidence suggesting a beneficial connection between interrupting sedentary time and metabolic risk (Healy et al., 2008), and of light physical activity and plasma glucose (Healy et al., 2007), the findings from the current study did not support this. The author was not satisfied that the potential health benefits of the intervention had been fully investigated in Study A and had a desire to find out more.

This motivation gave rise to Study B, designed to extend the findings drawn from Study A but more specifically designed to gain a greater understanding of the impact of the intervention on desk-based employees' health. To achieve this, a mixed methods study design was adopted whereby participants self-reported perceptions of health and completed a self-report of compliance with the intervention. An important lesson learnt from Study A was the difficulty of collecting objective data prescribed by some methodologies, and this informed the decision to include two self-report measures for collecting data in Study B. Obtaining detailed participant perspectives on using the intervention was also of interest, and learning if the intervention instigated any change in health behaviour at the workplace; so a qualitative element was introduced in the form of semi-structured interviews. This element had been absent from Study A, and the approach was adopted to contribute types of data that could not be captured through other methods. Collectively the self-report measures and interviews provided the platform for triangulation of data (Bryman, 2013), and fostered further investigation into how the intervention influenced the health of desk-based employees.

The research period for Study B was 26 weeks. The primary reason for the longer period was to gauge if the intervention was effective in interrupting POS and increasing NEAT when the prompt stimulus changed. Could behaviour change in workplace health behaviour activated by a passive prompt be maintained when the passivity of the prompt was removed? One aim of investigating this over a longer time frame was to discern how changes to the workplace environment could influence health behaviour, and how the environment could be manipulated to maintain particular behaviours. The 26-week research period also allowed for data collection at three time points: pre-test, post-test 1 at 13 weeks, and post-test 2 at 26 weeks. The intention of adopting a mixed methods research design and examining the health of desk-based employees at three time points over a longer research period was to acquire greater insight into how POS behaviour can be changed to improve health.

Chapter 4

Study B

Introduction

In the wake of the findings obtained from Study A, the aim of Study B was to examine if a workplace intervention designed to interrupt POS and increase NEAT was effective in initiating workplace health behaviour change, and if any such change was sustainable. The literature offers many studies which have investigated health outcomes associated with prolonged sitting, but typically these have focused on measures such as obesity, cardiovascular disease, metabolic syndrome and cancer (de Rezende, Rey-Lopez, Matsudo, & Luiz, 2014; Katzmarzyk et al., 2009; Thorp et al., 2012). Several studies have explored associations between prolonged sitting and mental health (Atkin et al., 2012; Hamer, Coombs, and Stamatakis, 2014; Sanchez-Villegas et al., 2010), with a particular focus on prolonged sitting and depression (Hamer & Stamatakis, 2014; Teychenne, Ball, & Salmon, 2010; van Uffelen et al., 2013). An element of previous research that has received little focus is the impact of prolonged sitting on general health, both physical and mental. To address this gap the Medical Outcomes Survey Short Form 36 (SF-36) (Ware & Sherbourne, 1992) was completed by a cohort of desk-based employees at three time points throughout the research period of Study B. Participants self-reported perceptions of health pre-test, after 13 weeks (post-test 1), and after 26 weeks (post-test 2).

To supplement the self-report of health, establishing if a relationship existed between participant perceptions of health and how the intervention was used by participants was of interest. Did regular and consistent self-reported engagement with the intervention lead to improved perceptions of health, or did sporadic and inconsistent self-reported engagement with the intervention contribute to decreased perceptions of health? To determine this a compliance to the intervention benchmark was established based upon the number of hours participants spent at work during a workday, and the number of times the intervention prompt would appear on the computer screen if they were to remain at their workstation the entire time. This benchmark allowed for the evaluation of compliance to the intervention for all participants over each of the workdays in the research period.

Compliance to the intervention was facilitated by the intervention prompt being administered passively for the first 13 weeks, and actively for the second 13 weeks. Findings from Study A had indicated that when the intervention functioned passively participants interrupted POS; therefore gauging if removing the passivity of the prompt after 13 weeks changed the POS and NEAT behaviour of the participants was important. Was exposure to an intervention featuring a passive prompt for 13 weeks enough to instigate health behaviour change and the development of a habit?

To complement the self-report measures detailed above, a qualitative framework was adopted to evaluate the efficacy of the intervention, using data collected through semi-structured interviews. The purpose of the interviews was to ascertain participant perceptions of the intervention, and to authenticate if engagement with the intervention influenced workplace social and ecological factors, which influence health behaviour (Bronfenbrenner, 1992; Duncan et al., 2005; Schneider & Stokols, 2009; Tamers, Beresford, & Thompson, 2011), and consist of the physical, social, environmental, emotional, and mental factors that influence individual and group beliefs and behaviour in the workplace. Bronfenbrenner recognised that behaviour was influenced at different levels, and established a systems framework to capture what social and ecological factors were influential in particular contexts. These levels of influence were articulated through the delivery of the semi-structured interviews specific to workplace health behaviour, a qualitative process grounded in the ontological realism of the data captured regarding the participants' experiences of engaging with the intervention (Madill, 2011). The mixed methods approach provided a robust framework to reveal accurate and reliable findings regarding health behaviour in the workplace. The primary purpose of this approach was to validate and justify the intervention used in this study as effective in instigating sustainable POS behaviour change.

Study design

Study B involved an experimental group who completed a pre-test self-report of health before being exposed to an intervention which featured a passive prompt for 13 consecutive weeks. This was called the passive prompt period. Midway through this period (between week six and week eight) a random selection of participants were interviewed. Following the passive prompt period all participants were post-tested with the same measurement included in the pre-test, and selected participants were interviewed for a second time. The second 13 weeks of the study involved participants continuing with access to the intervention; however this access differed in that it was voluntary. This was called the active prompt period. Selected participants were again interviewed, for a third and final time, between week six and week eight of the active prompt period. At the end of this period all participants were post-tested a second time. During both the first 13 weeks (passive prompt) and second 13 weeks (active prompt) the sitting and standing behaviour of each participant was monitored by self-report, with the intervention software containing an in-built device that recorded sitting interruptions, activated by the participant. The software registered each time a participant engaged with the intervention, and the length of time of each engagement. Participants in Study B were a different cohort of employees from the TDPEM, and had no involvement with Study A.

An action research method was adopted to gain insight into the effectiveness of a workplace intervention to change participants’ POS behaviour, and subsequently their perceptions of health. According to Reason and Bradbury (2001), action research seeks to bring together action and reflection, theory and practice, in the pursuit of practical solutions to issues of pressing concern to people, for the enhancement of individuals and communities. Beyond this intention, the intervention was constructed to encourage desk-based employees to embrace desirable behaviours (Anshel & Kang, 2008); therefore this method did not include a control group. This design enabled the participants’ POS to be monitored during the active prompt period when they were not passively prompted by the software, and allowed investigation into whether the participants continued with the same behaviour with the active prompt as with the passive prompt. This would enable me to judge the sustainability of the intervention as an effective technique to change health behaviour in the workplace.

The action research approach to Study B was underpinned by a communitarian model (Forster, 1982) as a platform for the achievement of the workplace health goal of reducing POS by interrupting desk-based sitting and incorporating NEAT into the workday. This theoretical perspective was based on the goal of diminishing adverse health effects associated with POS through collective measures, because individual interest typically does not afford sufficient motivation to incur behaviour change when the perceived risk to the individual is low. A communitarian model is supported by a passive approach to prevention which requires minimal or no action (Roberts, 1987). By changing how desk-based employees interacted with their computers, and subsequently the workplace environment, it was intended that a social and economic culture promoting workplace health would be stimulated to reinforce behaviour change.

The data collection methods and research design used in this this study were devised to provide evidence to address Research Question 2 of this thesis:

> **RQ_2**: Can a workplace intervention designed to interrupt prolonged occupational sitting instigate and maintain health behaviour change in desk-based employees?

For this study, health was operationally defined by the self-reported perceptions of health, using SF-36 (Ware & Sherbourne, 1992). Health behaviour change was operationally defined by the dependent variable of compliance with the intervention, with compliance measured by self-report in both the passive and the active prompt periods and then compared to establish any change in health behaviour between the two periods. To substantiate the operational definition of health and health behaviour change in this study, several questions in the semi-structured interviews directly addressed participants' perceptions of individual health, organisational health behaviour, and health behaviour change in the workplace. These questions were designed to inform the data collected from the self-report measures, but to also elicit data that could not be accessed from the self-report tools. The three data collection methods, SF-36, compliance with the intervention, and interviews, allowed triangulation of the data to address Research Question 2.

Based on the operational definitions of health and health behaviour change two hypotheses were designed. Further to the findings reported from Study A and other health research recommending the amount of time required to develop a sustainable behaviour that becomes habitual (Lally et al., 2010), it was hypothesised that:

> **N_0**: A workplace intervention designed to interrupt prolonged occupational sitting will not improve self-reported health of desk-based employees.

H_1: A workplace intervention designed to interrupt prolonged occupational sitting will improve self-reported health of desk-based employees.

N_0: A workplace intervention designed to interrupt prolonged occupational sitting will not instigate and maintain health behaviour change in desk-based employees.

H_2: A workplace intervention designed to interrupt prolonged occupational sitting will instigate and maintain health behaviour change in desk-based employees.

Participants

Desk-based employees from the Tasmanian Department of Police and Emergency Management (TDPEM) were invited by their occupational health and safety officer to volunteer to participate in the study. The TDPEM is a structured organisation represented by 70 stations spread throughout the state of Tasmania, each varying in size and infrastructure. Participants ($N = 54$) were randomly selected from 460 volunteer desk-based TDPEM employees, using a computer-based random numbers generator. The random selection was based on the number of desk-based employees in each of the south, north, and north-west regions of the state, and the percentage of desk-based employees specific to that particular region. A minimum of ten per cent was deemed a manageable sample size in terms of a PhD project by the PhD supervisory team. The occupations of the participants varied between roles such as reception duties, administrative support, call centre, forensic analysis, community liaison, media liaison, transcription, and sworn duties. No participants withdrew from the study and all completed pre-test, post-test, and second post-test measurements.

The gender difference among the participants (female = 39, male = 15) was indicative of the TDPEM office-based workforce, two thirds of whom were female. Participants were pre-screened to determine if they met the inclusion criteria for the study: that employees were full-time and worked eight hour daily shifts and primarily had desk-based job responsibilities; used a desktop personal computer to perform their work; were prepared to engage in behaviour change, operationally defined as being in the contemplation, action, or relapse stage of Marcus et al.’s (1992) stages of change categories; and were medically able to perform short bouts of daily physical activity (PAR-Q: British Columbia Ministry of Health, 1978). PAR-Q requires all participants to answer ‘yes’ or ‘no’ to seven questions about health and physical activity, framed around the presence of a heart condition, chest pain, losing balance because of dizziness or losing consciousness, joint problems, current prescription drugs for blood pressure or heart condition, and any other reason that physical activity should not be performed. If participants answered ‘no’ to all questions, or ‘yes’ to one question but provided clearance from a general practitioner, they were deemed medically healthy to perform short bouts of daily physical activity. If participants answered ‘yes’ to more than one question they were excluded from the study.

Eleven individuals were excluded: seven who were not primarily desk-based; two participants, although desk-based, who did not have desktop internet access; and one who was not medically cleared to participate in workplace physical activity. Following the exclusion of the individuals the sample cohort for this study was 43 participants, 31 females and 12 males (N = 43; *mean age* = 43.81 +/-9.94). All participants provided informed consent prior to any data collection, in accordance with University of Tasmania ethics procedures (Appendix A). Participant demographic details are provided in Table 7.

Table 7

Participants' demographic data. Values are means (*standard deviations*)

Gender (N = 43)		Age (years)	Weight (kg)	Height (cm)	Body mass index (%)
Female	31	42.03 (*11.93*)	71.46 (*12.10*)	163 (*6.19*)	26.65 (*4.62*)
Male	12	45.59 (*7.95*)	97.75 (*16.99*)	179 (*4.78*)	30.57 (*5.54*)

Procedures

Orientation session. After the initial screening for study inclusion, remaining participants attended an orientation session in a computer laboratory at police headquarters. The purpose of the session was to discuss the procedures of the study, complete a self-report of health, and to undergo induction training for the study. This session was conducted on three separate occasions: one for the participants from the southern region of Tasmania (n = 28), one for participants from the northern region (n = 6), and one for the participants from the north-west (n = 9). All three sessions were conducted in the same week, and were coordinated by a research team consisting of myself, two PhD supervisors, and the TDPEM Occupational Health and Safety Officer. Each venue provided access to desktop computers on which participants completed a self-report measure of health. The procedure and delivery of the session was identical to that of Study A.

The intervention: Exertime

The intervention used for the current study was an interactive computer-based software program titled 'Exertime' (Cooley & Pedersen, 2009), designed to prompt employees to interrupt long bouts of sitting by periodically standing up to engage in a brief bout of NEAT. The Exertime sequence was initiated every 45 minutes as a prompt bubble emanating on the bottom right hand side of the computer, occupying a large part of the screen. The functionality of the intervention in this study was identical to that in Study A for the passive prompt period, and participants engaged with the intervention through the same method used by those in the experimental group in Study A.

Passive prompt period. Participants had the Exertime software installed on their desktop computer immediately after the pre-test, for a 13-week period. The passivity of the prompt featured in this software meant that participants had no control over the prompt appearing, and so involuntarily engaged with the software, without making a conscious decision (Williams et al., 2000). The only modification that the participants were able to make once the prompt appeared was to use the postpone function to delay selecting an activity, but this did not remove the passivity of the prompt continuing throughout the workday. Upon being prompted, participants were able to view any of 65 brief video demonstrations of a model employee performing NEAT activities in an office environment. It did not matter which activity was selected, because any time employees were not sitting during work was considered Exertime, and the software was designed to record interruptions to POS. Between week four and week six of the passive prompt period all participants received a call from the research team while at work, to confirm that they were accurately reporting their progress in the Exertime activities.

The Exertime software featured a ‘postpone’ function which enabled the participants to temporarily delay the prompt for a selected time period (e.g., 10, 30, or 60 minutes) before it reappeared on the screen. This could be activated for a maximum time of one hour only. If an employee reached the maximum postponement time the function became inactive, forcing the employee to engage with Exertime every hour of the workday. The inclusion of a postpone function was based on the expectation that a participant might be involved in a phone conversation or a meeting, or might need to access computer-based information rapidly; in such a situation the employee could choose to postpone the prompt.

The frequency of daily usage of the program for each participant was automatically recorded by the software once the program was activated by the participant. For example, if an employee worked an eight-hour day with a one-hour lunch break, and he or she chose to engage with the prompt each hour with no postponements, then the software would record seven Exertime engagements for that day, indicating full compliance. If an employee chose to postpone the prompt for an hour at some point, then he or she would be recorded using the Exertime program less than seven times for that day.

Active prompt period. Immediately after the completion of the 13 weeks of passive prompting, participants had the prompt feature removed from their computers. The software remained on the computer, so the program could be accessed voluntarily: that is, Exertime activities could still be performed, but the participants were not prompted to stand and move. The intervention was user-activated only throughout the second 13 weeks of the study. The active prompt featured as an ‘Exertime’ icon permanently on the computer screen, in the bottom right hand corner in the toolbar, smaller than the prompt of the passive period. The purpose of this was to emphasise the voluntary nature of participants interrupting POS and engaging in NEAT. The prompt is depicted in Figure 7.

Figure 7: Exertime active prompt

The intention of including an active prompt period was to ascertain the impact over time of such a prompt on the workplace health behaviour of participants. Was the prompt persuasive enough to have a lasting effect on the health behaviour of the participants, to the extent that they continued standing and moving voluntarily; or did they need to be reminded by something more insistent for this behaviour to be maintained? The active prompt period also allowed insight into the possible development of a habit of interrupting sitting regardless of a prompt being present or not, or the relapse into POS habits once the passive prompt feature was removed.

Inventory: Self-report

Medical Outcomes Survey Short Form 36 (SF-36). A primary aim of this study was to measure the effect of a passive intervention on the health of participants throughout the research period. SF-36 was used in this study as a generic measure of health which yields a physical health component score, a mental health component score, and a combination of these for a total health score. There were eight individual scales: four of these, Physical Functioning, Role-Physical, Bodily Pain, and General Health, contribute to the Physical Component Summary score, and the other four, Vitality, Role-Emotional, Social Functioning, and Mental Health, contribute to the Mental Component Summary score. The scales in both the Physical Component and Mental Component Summary scores provide information relevant to how each participant in this study might view their health (Mainsbridge, Cooley, Fraser, & Pedersen, in-press). SF-36 has been used as a measure in a variety of different domains, including hospitals and health care facilities, and with physical and psychological rehabilitation cases (Ware, 2000).

Participants in this study self-reported their health for each of the eight scale profiles at the pre-test, post-test, and second post-test periods. Each of the 36 items on the SF-36 survey was scored on a 0–100 scoring algorithm, then collated based on which of the eight scales they aligned with, and an average score was established for each scale. The four average scores for the Physical Component were combined and averaged to establish a Physical Component summary, and the same procedure was used to derive the Mental Component summary. To calculate a Total Health SF-36 score these two values were combined and averaged. The SF-36 inventory is in Appendix F.

Daily frequency of participation self-report (compliance). On each occasion that a participant stood and engaged in NEAT, the action was self-reported by the participant. This was done by participants selecting the ‘Exertime now’ button when prompted by the prompt bubble during the passive prompt period, or by voluntarily clicking on the Exertime icon in the toolbar during the active prompt period. This automatically provided the research team information related to the number of times POS was interrupted per workday. It allowed comparison of the number of times that the participants stood when prompted passively, against the number of times they stood when actively and voluntarily engaged.

The frequency of activity per day during the passive and active prompt periods functioned as a measure of compliance. Based upon the number of prompts that the participants received in an eight hour workday, compliance was defined as recording seven or more Exertime activities in a workday, which was defined as an eight hour shift with a one-hour meal break. During the passive prompt period, if participants spent an entire workday with the exception of lunch at their desk, they would receive the prompt on their computer screen a minimum of seven times. This number was based upon the prompt appearing on the participants' computer screen at 45 minute periods throughout the workday, with allowance for the postpone function to be used once in every hour. A record of six or fewer Exertime activities in a workday was defined as non-compliance. The same measure of compliance was used during the active prompt period, allowing easy comparison of the frequency of engagement with the intervention between the passive and active prompt periods.

The possibility of no activity being reported during the research period did exist, but these days were excluded from the final results because it was not possible to determine the reason for the non-entry or what days indicated non-compliance or compliance. Possible reasons for no activity being logged on a day or multiple days included participants being on medical or annual leave, or being away from the workstation for an entire day and not being able to access a computer. On workdays when participants could not access a computer but continued to interrupt POS and complete additional movements but failed to log them, the probability that there was under-reporting of the number of activities logged for both passive and active conditions existed.

Data Analysis

Descriptive statistics for the dependent variable measuring health were reported in tabular form as means and standard deviations. Scores for each of the SF-36 Summary scales were reported for the experimental group across time, with reliability for each scale determined using Cronbach's alpha coefficient (*a*). Intra-class correlation coefficients and 95% confidence intervals were calculated for the mean values of each of the summary scales to enable comparisons of internal consistency of the SF-36 Summary scales in this study with the original values reported by Ware (2000).

One (Group: Experimental Group) x three (Test: Pre-Test/Post-Test/Second Post-Test) ANOVAs were used to determine any significant differences in the health dependent variable. Alpha levels were set a priori at 0.05 for all inferential tests of significance. Any significant interactions were further examined using simple main effects analyses. Cohen's *d* statistic was used to calculate the effect size of the mean values between pre-test, post-test 1 and post-test 2.

To analyse the daily frequency of participation compliance dependent variable, an odds ratio was generated using a Two (Compliance/Non-compliance) x Two (Passive Prompt/Active Prompt) contingency table. The benchmark for compliance was based on participants' engaging with the intervention a minimum of seven times throughout a workday. All data were analysed using PASW version18.0 (SPSS Inc., 2009).

To facilitate greater insight into the effectiveness of the intervention to instigate and maintain health behaviour change in desk-based employees, qualitative data generation was undertaken to obtain participant data that could not be articulated through self-report measures. The evaluative method afforded the perceptions of the participants regarding the merit of the intervention to change workplace health behaviour (Cooley, Pedersen, & Mainsbridge, 2013). This qualitative data also served to substantiate what the self-report measure and frequency of participation compliance measure revealed during the 26 week research period.

Qualitative Measures: Methodology

Participants. To select participants for the qualitative evaluation, two factors were used to guide recruitment. First, in terms of saturation (Cohen, Kahn, & Steeves, 2000), an a priori limit was selected (n = 15); chosen for pragmatic reasons and for recommendations from previous research. It was deemed unnecessarily interruptive to TDPEM to interview all participants, either face-to-face or in focus groups, given their geographical dispersion and the nature of the workplace. Similar study designs (i.e., Renton et al., 2011) have shown saturation after 15–18 interviews. Given these factors, 15 participants were randomly selected for the qualitative evaluation.

Selection was carried out using a computer-based random stratified protocol to ensure representation from all geographical locations. The selection was based on the number of desk-based employees in each of the south, north, and north-west regions of the state, and the percentage of desk-based employees specific to that particular region. A geographical stratification was decided upon because each work area was unique in terms of staff numbers and physical and built environment. To ensure the a priori numbers were met, two in-waiting participants were selected as alternates. All first selected participants (n = 15) were contacted and informed of the purpose of the interviews and all consented to participate; no alternates were required.

The participants involved in the qualitative analysis (females = 11 and males = 4; *mean age* = 43.00 +/-3.21 years) worked in multi-storey buildings between two and seven floors in height (*n* = 12), and the remainder in single storey buildings. Many worked in small administrative groups of three to ten people. Some worked in single situations because of their geographical location or type of work. Some worked shift work (*n* = 4), with the remainder working between 9:00 am and 5:00 pm.

Interview design. Given that the intervention in this study covered a single organisation and a small group of its employees, the questions were designed to explore only the microsystem, mesosystem, and exosystem levels of Bronfenbrenner's (1992) model; the macrosystem was excluded because it relates to influences of societal norms, laws, and cultural values. The organisation of the microsystem, mesosystem, and exosystem categories reflected the structure of the interview. A preliminary schedule of questions was developed, so the interview was semi-structured (Appendix G); the schedule contained broad areas to be discussed and was revised in-situ as new topics were raised during the interviews. The broad areas related to participants' self-perceptions of any changes that had occurred at individual, work group, or organisational level. Because this was not solely a quantitative study, some level of subjectivity was required in terms of interpretation and conclusions drawn from the data; hence, categorisation reflected trends and nuances.

Procedures. Interviews were conducted in the work offices of the participants. Participants were informed that the lead researcher was interested in their honest and frank opinions. At no stage were the terms outcomes or evaluation used. The interviews began with general questions and discussion not related to the study variables. When rapport was established, exploring the participants' experiences of the study began. The duration of each interview was approximately 35 minutes. Each interview was digitally recorded, downloaded to a computer and transcribed verbatim. Ten days after the interview the participant was contacted by phone and given the opportunity to add to or subtract from the interview responses, and to further clarify any points.

Data analysis. Several authors have suggested methods for identifying how data are coded and categorised for optimum analysis and interpretation (Constas, 1992; Martin, Marsh, & Debus, 2003). These suggestions were followed by identifying an audit trail that included origination, verification and temporal designation (Roy, Hamidan, & Singh, 2011). In this study, origination emanated from (a) personal interests and theoretical viewpoints (e.g., the outcomes of an intervention across influencing factors were explored through a research structure with lived experience as a central component in evaluation), (b) the literature (e.g., conceptualising potential outcomes as described in a social ecological model (Bronfenbrenner, 1992) as the basis on which participants' experiences were described), and (c) participants' responses (e.g., participants identified issues not anticipated by me or central in the literature).

Categorisation for data verification was guided by (a) rational consideration, in which categories have face validity and the appearance of logical connection (e.g., whether the category directly reflected the core research questions related to exploring outcomes of an intervention), and (b) referential considerations in which established research findings were used to justify the category generation (e.g., social ecological research addresses the issue of multiple influences and hence outcomes of an intervention); categorisation was developed to account for this. A priori theory-driven category development was used for temporal design. These categories were microsystem (individual outcomes experienced), mesosystem (self-report of outcomes experienced within a work group or larger work area), and exosystem (perceptions of outcomes that affected the organisation), which reflected the varying factors of the social ecological model. There was a degree of iterative processing with the emergence of sub-categories in response to participants' reports.

A typological analytical approach was used in analysis (Lincoln & Guba, 1985) because the theory drew upon Bronfenbrenner (1992) to guide the development of questions and categories and the way in which data were sorted. Bronfenbrenner's model was used for the theoretical basis for two reasons. First, the model presents a robust framework for measuring outcomes and for understanding the effect of an intervention within the person-in-context. Second, other social ecological models are quite complex, containing myriad systems. Given that this intervention targeted the individual rather than a whole organisation, by physically changing the individual's environment (i.e., by delivering the intervention through each participant's computer) the parsimonious nature of Bronfenbrenner's model and the systems within it best suited the aim of this study.

Interview data were analysed using the NUD*IST software program (Richards, Richards, McGalliard, & Sharrock, 1992). Using this to store, manage and analyse data enabled me to achieve the exploratory and explanatory purposes of the study. Important concepts that emerged from the data were labelled and categorised (Patton, 2002). The transcripts were independently read and re-read by me and a research team from the University of Tasmania and TDPEM, and ideas about evidence to support each of the main categories were noted. Following the completion of categorisation the author consulted with the research team; categories were compared and disagreements discussed. Peer examination guards against bias and enhances the strength of findings (Burnard, 1991). Evidence was grouped into each of the three main categories (microsystem, mesosystem, and exosystem). Given the size and nature of the organisation and the small number of participants, it was decided against publication of specific age, work designation, work area, and work type, as these could have contributed to participant identification.

The section below presents results for self-reported health, self-reported frequency of participation and compliance, and a summary of the qualitative data findings from the semi-structured interviews. The qualitative data will be further detailed in the discussion section to provide interpretation of the lived experiences of the participants throughout the research period.

Results

Descriptive statistics for the experimental group by test, and intraclass reliability results for the SF-36 categories, are presented in Table 8. Cronbach's alpha statistic (α = 0.64) indicated 'questionable' reliability of the pre-test, post-test, and second post-test SF-36 responses (George & Mallery, 2003). This finding may be related to the small number of participants in the study.

Table 8

Descriptive statistics are the values reported for the separate SF-36 categories as a function of group and test. Values are presented as means (*standard deviations*)

Experimental Group (*N* = 43)					
SF-36 Category	Pre	Post	Second Post-test	ICC	95% CI
Total health	63 (*7*)	80 (*14*)	81 (*14*)	0.63	(0.40, 0.79)
Physical health	59 (*8*)	79 (*14*)	80 (*13*)	0.66	(0.43, 0.80)
Mental health	54 (*5*)	76 (*16*)	78 (*17*)	0.35	(0.074, 0.63)

The ANOVA results revealed a significant interaction between group and test occasion, $F(2, 42) = 2.79$, $p < 0.05$, such that the experimental group increased their total health from pre-test (*M* = 63 +/- 7) to post-test (*M* = 80 +/- 14) to second post-test (*M* = 81 +/- 14) with a medium effect size of Cohen's *d* = 0.37. Follow-up analysis utilising Tukey's HSD revealed a significant difference between the mean values for the experimental group. The significant increase in total health was a product of the composite values self-reported in the physical health component and mental health component. The experimental group increased their physical health from pre-test (*M* = 59 +/- 8) to post-test (*M* = 79 +/- 14) to second post-test (*M* = 80 +/- 13), with a medium effect size of Cohen's *d* = 0.39; and increased their mental health from pre-test (*M* = 54 +/- 5) to post-test (*M* = 76 +/- 16) to second post-test (*M* = 78 +/- 17), with a low effect size of Cohen's *d* = 0.15.

Descriptive statistics for the experimental group by test, and intraclass reliability results for the SF-36 scales, are presented in Table 9.

Table 9

Descriptive statistics are the values reported for the separate SF-36 scales as a function of group and test. Values are presented as means (*standard deviations*)

Experimental Group (*N* = 43)					
SF36 Scale	Pre	Post	Second Post-test	ICC	95% CI
Physical Functioning	88 (*11*)	90 (*12*)	92 (*11*)	0.91	(0.00, 0.39)
Role-Physical	78(*29*)	87 (*24*)	92 (*18*)	0.45	(0.02, 0.24)
Bodily Pain	62 (*16*)	84 (*16*)	83 (*17*)	0.25	(0.10, 0.52)
General Health	27 (*13*)	62 (*20*)	78 (*17*)	0.14	(0.21, 0.89)
Vitality	34 (*12*)	62 (*20*)	70 (*19*)	0.18	(0.11, 0.83)
Social Functioning	79 (*18*)	84 (*18*)	88 (*16*)	0.59	(0.08, 0.14)

Role-Emotional	71 (*23*)	81 (*28*)	91 (*23*)	0.34	(0.01, 0.41)
Mental Health	59 (*6*)	78 (*15*)	81 (*12*)	0.27	(0.01, 0.54)

Over the 13-week period between pre-test and post-test, mean values for each of the eight SF-36 scales improved. This pattern was also observed in the mean values for each of the eight scales for the 26-week period between pre-test and the second post-test., All scales with the exception of Bodily Pain improved for the period between post-test and second post-test.

Daily frequency of participation self-report (compliance). The presence of a passive prompt increased the odds of compliance OR = 1.10, whereas the active prompt proved to have only a minimal impact on the odds of compliance (OR = 0.23). Comparing the two periods, a passive prompt improved the odds of the participants interrupting POS and standing every hour nearly five times more than the active prompt (OR = 4.78; 95%CI – 3.78-5.93). The use of an intervention designed to interrupt POS and increase NEAT during a working day was more successful when the decision to engage in standing and subsequent movement was largely involuntary than when the decision to participate was voluntary. The number of days for compliance and non-compliance in both the passive prompt period and active prompt period are presented in Table 10.

Table 10
Total number of days for compliance and non-compliance in each prompt condition

Experimental Group (*N* = 43)	Passive Prompt	Active Prompt
Compliance	1216	108
Non-compliance	1104	465

The self-report frequency of participation and compliance measure indicated that participants recorded a total of 2894 days on which at least one Exertime activity was logged. The greater percentage occurred during the passive prompt period (n = 2320 days). The highest number of activities logged by a participant for one day was 23 in the passive prompt period, compared to 16 activities logged by a different participant in one day during the active prompt period. The highest percentage of total days recorded nine activities in one day (12 per cent of days) during the passive prompt period, compared to one logged activity per day during the active prompt period (37 per cent of days during the 13-week period).

Semi-structured interviews. In synthesising the qualitative data from the responses to interview questions, outcomes were organised into three systems identified by Bronfenbrenner (1992). In line with his model, the data provided evidence of reciprocal determinism between the systems: the installation of the intervention on the participants' computers (microsystem) changed the built environment (exosystem), which in turn changed employees' behaviours (microsystem). Similarly, changing some participants' behaviours (microsystem) resulted in changes to the immediate work environment, which caused changes to the behaviours of other employees (mesosystem) who were not part of this study.

At the microsystem level, all participants (n = 15) provided data indicating that their involvement in the workplace intervention had been beneficial at an individual level. Participants explicitly commented that the intervention had a positive impact on motivation, provided feelings of success, fostered the development of a healthy habit in the workplace, and promoted positive thoughts about nutritional choices and body weight. At the mesosystem level the majority (n = 12) provided evidence to support how the intervention affected both the physical and social workplace environment.

Characteristic comments related to how the intervention affected workplace climate, how engagement with the intervention promoted social interaction between colleagues, and how the introduction of the intervention on the individual computers of the participants influenced workflow. At the exosystem level several participants (*n* = 6) suggested that the intervention had been effective in creating awareness of the adverse health effects of POS and reinforcing the importance of interrupting the behaviour regularly. Participants said that engagement with the intervention had changed how they viewed exercise, and what was required to exhibit healthy behaviour.

The data obtained from the semi-structured interviews will be elaborated on in the discussion section of this chapter. The microsystem, mesosystem, and exosystem levels identified by Bronfenbrenner (1992) will be expanded upon with relevance to the data provided by the participants. Precise responses from participants to the interview questions will be included to provide evidence to clarify the categorisation of data in the relevant system.

Discussion

This study examined whether a workplace intervention designed to interrupt POS and increase NEAT was effective in initiating workplace health behaviour change, and if any such change was sustainable. To address Research Question 2 of this thesis, a mixed methods approach was designed to elicit accurate and reliable findings regarding health behaviour in the workplace, and to determine if the intervention used in this study was effective in instigating sustainable POS behaviour change. Health was operationally defined by the participants' self-reported perceptions of health using SF-36 (Ware & Sherbourne, 1992). An action research approach was adopted to verify the effectiveness the intervention to change participants' POS behaviour and subsequent perceptions of health, with participants self-reporting significant improvements in health 13 and 26 weeks after exposure to the intervention. Results from the ANOVA revealed a significant interaction between group and test occasion, demonstrating that the experimental group increased their total health from pre-test to post-test, and from pre-test to second post-test. The significant increase in total health was a product of improvements in the composite values self-reported in the physical health and mental health components of SF-36. These results indicated support for Research Hypothesis 1, that a workplace intervention designed to interrupt prolonged occupational sitting will improve self-reported health of desk-based employees.

The SF-36 values for total health, physical health, and mental health, reported at pre-test by the participants in this study, were similar to Australian averages for other adults using the same instrument (Butterworth & Crosier, 2004). At the post-test time point the values for each category had increased to be recognised as ‘high’, with each category again increasing marginally at the second post-test to remain ‘high’. The SF 36 guide suggests that a difference of 10 points per health category indicates a clinically worthwhile difference (Ware, Kosinski, & Dewey, 2000; Ware, Snow, Kosinski, & Gandek, 1993); and these improvements can be regarded as clinically worthwhile in that both physical and mental health scores increased more than 10 points between pre-test and post-tests, and between pre-test and second post-test. Participants self-reported that their perceptions of health improved as a consequence of the workplace intervention. These results suggest that when the intervention functioned passively workplace health behaviour changed with the periodic interruptions to POS and the increased NEAT, and consequently participants felt more positive about their health. Moreover, the passive prompt had a lasting effect on participants’ perceptions of health, as self-reported values of health persisted throughout the active prompt period as well. This finding demonstrates that the passive prompt had a lasting effect in regularly reminding participants to engage in healthy workplace behaviour, and may have been instrumental in the development of a habit. Evidence for the development of a habit is supported by the sustainability of self-reported health values, suggesting that the participants continued to interrupt POS and perform NEAT at their discretion. Thus, it may be asserted that an active prompt is an effective mechanism for desk-based employees to maintain their perceptions of health following a 13-week intervention using a passive prompt.

Previous researchers have acknowledged that the long-term sustainability of many health interventions has undergone insufficient investigation (Chau et al., 2010; Koster et al., 2012; van Der Ploeg et al., 2012). Typically, studies of health interventions specific to the workplace have ranged from durations between two and 12 weeks (Krebs, Prochaska, & Rossi, 2010; Leslie et al., 2005; Napolitano et al., 2003; Pressler et al., 2010), thus recommendations regarding health and sustainability have been backed by little evidence. To address this gap this study was conducted over a six month period, by conducting a self-reported inventory at three time points throughout the six month period, and by using a reliable and valid inventory that provided a holistic representation of health (Chau, 2009). In this study, increases in each of the eight scales which comprise the physical and mental components of the SF-36 were self-reported between pre-test and post-test. Specific to the physical component, participants showed that engagement with the intervention improved their ability to cope with work activities without limitations, reduced pain, improved their ability to perform all types of physical activity, and enhanced personal health. Crucially, despite the intervention in this study being developed around a framework of interrupting POS and increasing workday movement, mental health also improved. Participants noted that engagement with the intervention improved energy levels, emotional problems with worked lessened, social activities were not interfered with as a result of emotional or physical problems, and feelings of peace, happiness, and calmness also improved. In regard to the sustainability of health, seven of the eight SF-36 scales improved after 26 weeks at the second post-test beyond the values reported at pre-test; hence, the intervention used in this study, designed to interrupt POS and increase NEAT, was the catalyst for improving the self-reported health of desk-based employees.

Daily Frequency of Participation Self-report (Compliance)

Although the participants' perceptions of their health in this study were favourable, these were not reflected in the data on health behaviour change; moreover, the self-reported frequency of participation compliance results conflicted with the trend observed in the self-reported health results. Results for compliance to the intervention revealed that a passive approach resulted in desk-based workers being five times more likely to comply with a health behaviour request than a voluntary, active approach. This result does not support Research Hypothesis 2; that a workplace intervention designed to interrupt prolonged occupational sitting will instigate and maintain health behaviour change in desk-based employees. Although the passive prompt period in the first 13 weeks incurred regular days of compliance from the participants and instigated health behaviour change, this behaviour change was not observed in the second 13 weeks when passivity was removed. If desk-based employees were to interrupt POS and execute NEAT sustainably, they needed to be prompted passively (Neuhaus et al., 2014). Moreover, to maintain adherence to the Work Safe Australia guidelines (1996) for desk-based workers that recommend standing from a seated position every hour, participants in this study needed a passive prompt that removed the need to decide to act.

In light of the self-reported perceptions of health results in this study, the opposing compliance result raises a point of contention. Self-reports from the SF-36 inventory clearly indicated that health improved during the passive prompt period, and continued to improve or was maintained during the active prompt period. Based on this pattern, one might argue that the improvement in health was based on a health behaviour changing and being maintained. Such a viewpoint is not supported by the findings in this study. One possible way to explain this paradox draws on the health behaviour change research of Lally et al. (2010), who found that the average amount of time for a new behaviour to develop into a habit was 66 days. In this study, with the appearance of the prompt passively at 45 minute intervals over a 13-week period, the likelihood of the response to the prompt becoming a habit was high. As the development of a habit occurs through frequent and repeated exposure to new environmental cues (Aarts & Verplanken, 2000; Ouellette & Wood, 1998), it is conceivable that some participants continued with POS behaviour change automatically throughout the active prompt period, without consciously engaging with the intervention and reporting activity. Consequently, reports of health remained elevated from pre-test but reports of interaction with the intervention and compliance decreased. Further evidence of this was identified in the semi-structured interviews, with participants commenting that during the active prompt period they used alternative reminders such as the news coming on the radio or setting their watch alarm every hour to stimulate interruptions to POS.

In considering the effect of habit on behaviour to describe the disparity in compliance between the passive and active prompt periods, there was a possibility that participants would revert to their pre-study behaviour of remaining seated at work. That is, not being prompted passively throughout the active prompt period allowed the participants to slip into their previous POS behaviour, and interrupting POS was discontinued. Habits are described as learned sequences of acts that have become automatic responses to specific cues (Hull, 1943; James, 1890; Tolman, 1932; Triandis, 1977, 1980; Watson, 1914); all the desk-based participants in this study would have found that habitual actions related to their occupations and POS were difficult to change. Based on this reasoning, despite the intention of participants to interrupt POS, past POS behaviour predicted future POS behaviour and the familiar, stable workplace context fostered sitting. Ouellette and Wood (1998) noted that well practised behaviours performed in stable contexts were likely to be repeated, and that conscious deliberation and decision-making were required to initiate and execute new behaviours. In this sense well practised POS behaviour became prominent in the active prompt period, and the novel behaviour of interrupting POS and increasing NEAT required greater conscious thought and therefore occurred less often. It is possible that the 13-week time frame for the passive prompt period was not long enough to establish a new workplace habit and make the behaviour change sustainable.

Other factors could have contributed to the gap in compliance observed between the passive and active prompt periods this. First, it is conceivable that during the active prompt period several participants continued to interrupt POS and perform NEAT without activating the software program on their computer. If so, continuing to execute the behaviour in an involuntary, unconscious and automatic fashion would indicate that a habit had been developed (Aarts & Verplanken, 2000), and that there was no need for the participants to log their activity. Second, when the prompt appeared passively it filled a large part of the computer screen and could not be ignored, and the software program had to be physically engaged with by the participant to advance further or to return to work. This delivery method has similarities with other communitarian initiatives underpinned by a passive approach to improve population health (Forster, 1982; Roberts, 1987). The active Exertime prompt icon was smaller and remained on the screen continuously in the bottom right hand corner, and could be ignored. These differences in the manner in which the participants were prompted had the potential to influence how they interacted with the intervention, particularly during the active prompt period.

The degree of compliance recorded in the passive and active periods has several implications. In terms of a communitarian model (Forster, 1982), it seems that health professionals should consider a more passive approach to participation to achieve greater compliance. The passive approach did offer some freedom in terms of activity and level of engagement to the participants, yet it is possible that imparting this level of freedom was the tipping point for the non-compliance exhibited during the second 13 week period of this study. Increasing compliance leads to greater effectiveness in health interventions designed to reduce mortality and morbidity (McNaughton & Shucksmith, 2014), offering the potential to reduce continuous and long-term costs associated with cardiovascular disease. The intervention used in this study incorporated NEAT movements that were not the common, popular types of activity, and national physical activity guidelines were not used. The activities were promoted as simple movement-based routines that could be completed in the course of a normal day’s work. The design, accessibility, and user-controllability of the intervention changed participants’ perceptions of what had to be completed to have an impact on their health.

To substantiate what the self-report health and compliance measures revealed during the 26-week research period, semi-structured interviews were administered at set points throughout both passive and active prompt periods. A central focus of the qualitative measure was any social ecological factors that affected how participants changed sitting or movement behaviour, and how engaging with the workplace environment affected health. Any theme that appeared regularly in the participants’ responses to the interview questions were categorised as an outcomes at the microsystem, mesosystem, or exosystem level of Bronfenbrenner's model (1992).

Outcomes at the Microsystem Level

Category: play. Recurrent evidence from the data (*n* = 7) were reports of how engagement with the intervention led to changes in motivation, independence, and success. These data were labelled as play because the commentary revolved around participants expressing sentiments that their concept of being physically active now included aspects of enjoyment and freedom (Reio & Wiswell, 2000). A sworn officer who did not engage in purposeful physical activity seemed at first to be attracted to the intervention because of the lack of time restraint and a non-failure environment. The officer explained at the conclusion of the passive prompt period,

> It appeals to me not having to do stuff at lunchtime but throughout the day as part of my work. Selecting what you did and how much you did was great, it didn't matter that I would only do short periods of exercise, I set my own goals depending upon how I felt. This is like you know those X-Box games, my kids come home from school and sit on that damn thing all afternoon, but then I thought about it I do the same at work, sit, so why not try it I thought. It was good to find all the different exercises. There are some exercises that I would not do as they are not appropriate for office clothes but there were others that enabled me to participate and feel successful. (Participant 27)

Such comments indicated a sense of personal achievement and satisfaction, and indicated that performing activities throughout the workday had become a game-like routine.

Likewise, a forensic-based employee who was a regular participant in purposeful physical activity expressed the sentiment of several participants that the intervention promoted a sense of independence, centred on the perception that any level of activity was acceptable. The officer shared during the passive prompt period:

> I saw it on the intranet (advertisement for the study) but this looked interesting. I like it on my computer, it was different, you were able to do as much or as little as you wanted, there was no failure. (Participant 12)

These experiences and feelings of independence were also evident in a changing of perceptions (*n* = 6) of what constituted being physically active for several participants. The officer continued:

> Running is what I do, but this was different, I kind of got into the whole moving all day and trying all of the exercises then seeing the feedback of how much energy I had burnt up. I was surprised that some things we take for granted can be healthy, like standing up to take a telephone call. (Participant 12)

A second sworn officer shared similar views following the active prompt period:

> I'm not an exerciser, but since the program has started I now realise that there are more ways to skin a cat, so I have been able to change what I do during the day you know, exercise. I don't get sweaty. Steps beside the photocopier, I'd never thought of that as exercise, but it was easy to do. It helped me stay in the program. (Participant 4)

These comments indicated that participants were able to make changes to their workday through the intervention, and that new forms of movement that they were introduced became routine. The variety of activities available in the intervention, and the ease in which they could be performed, appeared to assist adherence to the behaviour change.

Within the category of play, responses indicated that participants experienced a change in motivation because they could get personalised feedback. One community support officer commented at the conclusion of the passive prompt period:

> I was able to set my own goals and then seeing the reports and how I was successful at burning up calories and not sitting for prolonged times. I was making progress. I had not experienced that before. I like being able to do something. (Participant 22)

These results show that receiving information about the energy expended by performing short bouts of NEAT functioned as a motivation, nurturing a sense of achievement and satisfaction. An administrative support employee remarked during the passive prompt period: ‘This was something new for me. I’ve never kept records of what I do, but this was interesting to see little changes lead to decreased sitting times’ (participant eight). It appears that one outcome from interacting with the intervention was a change in participants’ views of engaging in NEAT, and of what constituted physical activity.

Category: health habit. Participants (*n* = 15) reported that involvement in the intervention had the benefit of increasing awareness about sitting habits, and this knowledge consciously modified their POS behaviour. A forensic-based employee remarked during the passive prompt period, ‘It has made me realise how much time I spend sitting. I now stand to talk on the phone, or after a phone call I will walk the stairs straight away. It’s helped my health’ (Participant 11). A sworn officer shared at the conclusion of the active prompt period: ‘Before the program I rarely stood up throughout the day but I almost automatically stand to do things now. I feel better for it although I’m not sure how much’ (Participant 27). A forensic-based officer explained following the passive prompt period: ‘I am definitely getting out of my seat more and I have become more active at work and away from work through this program' (Participant 12). An administrator explained during the passive prompt period:

> I am usually quite good about getting out of my chair normally, but the program has made it more scripted and regular. It breaks the day up and I feel better at the end of the day. This has definitely made me realise how much I sit. I would remain sitting if I was not prompted. I feel better. (Participant 20)

These comments show that the intervention was the catalyst for providing structure and routine by interrupting POS and making standing a permanent part of the workday. Participant 20 pointed out that if the passive prompt did not provide the stimulus to stand and move, then subsequent active behaviour would not occur and they would remain seated. The passive prompt proved effective in creating a conscious awareness in the participants of how much time they spent sitting. It seems that participation in the intervention resulted in desk-based employees modifying their POS habit for an hourly movement habit.

Emerging themes. Interview responses at different times throughout the research period identified a theme related to the interaction between engaging with the intervention and a flow-on effect to other health behaviours (n = 6) emerged. In acknowledging these emergent themes, it is important to recognise that the participants in this study might have been subject to selection bias because they possessed a level of motivation to change their health behaviour. Although weight reduction was not a targeted outcome of this study, a number of participants reported losing weight over the course of the intervention, or changing their eating habits. One clerical-based employee remarked at the conclusion of the passive prompt period, 'I do believe that doing the exercises sped up my metabolism. I have noticed that my trousers are looser' (Participant 17). A senior administrative support officer shared that using short bouts of

NEAT throughout the day had helped in weight control after the active prompt period: ‘I do not want to get rid of the program from my computer. It has stabilised my weight, and I have felt positive results within myself’ (participant 2). Linked to the outcome of weight loss were reports of changes in diet. For example, participant 17 shared during the passive prompt period: ‘The program has complemented recent nutritional changes, and it has helped me to decrease the amount of chocolate I eat’ (Participant 17). An administrative support officer reported during the passive prompt period, ‘I am now eating less biscuits while at work’ (participant eight). Such comments reveal that participation in the intervention indirectly affected characteristics such as weight and eating behaviours, not intended to be consequences of the study.

Another emergent theme was the mutuality between subsystems (Bronfenbrenner, 1992). This was apparent in participants (*n* = 8) who reported changes in leisure time behaviour as a result of changing workplace habits. After the passive prompt period a senior administrative support officer reflected following the passive prompt period: ‘I’m really conscious about prolonged sitting now. Every commercial break on TV, I get up to do something and then sit back down’ (Participant two). Two support officers who self-identified as long-term smokers reported that increasing their movement throughout the workday had reduced their smoking. Another employee agreed: ‘The program has been instrumental in helping me to give up smoking. It has been nine days since my last cigarette’ (Participant 11); and a clerical-based support officer remarked, following the passive prompt period: ‘The program got me started again on improving my health. I have cut down from smoking one pack every two days to one pack a week’ (Participant 33). Outcomes related to leisure time health behaviour and smoking behaviour were not intended in this study, yet the reports from these participants suggest that participation in the study had an effect on such behaviours, indicating that the intervention was influential in reducing the negative health habit of smoking and led to improvements in health.

This evidence indicates that the introduction of an intervention based on interrupting POS and increasing NEAT results in a range of individual health outcomes other than the intended preventative outcome of participants changing their workplace POS habits. This is not to say the intervention was directly responsible for these changes, but it appears that it might have afforded an opportunity for some to change other health behaviours. Although the participants' reports were categorised as part of the microsystem, the outcomes also have links to the mesosystem. The intervention software on participants' computers changed the physical work environment and thereby effected changes in behaviour.

Outcomes at the Mesosystem Level

Category: workflow. Any change in behaviour is subject to barriers and affordances, and it is not surprising that this was true for participants in this study. Within the context of Bronfenbrenner's (1992) model, most outcomes were positive, although evaluation showed that the passive prompt caused participants to suffer some angst at the forced interruption to their workflow. A front office receptionist said that during the passive prompt period:

> At first it was rather annoying to have my work interrupted by the prompt, I felt like I was getting into my work when all of a sudden I had to stop; it was particularly annoying at times. I was ready to withdraw. (Participant 43)

Several participants (*n* = 3) indicated that the advent of the intervention caused frustration and difficulty in adjusting to a new workplace behaviour. A senior administrative support officer remarked after the passive prompt period: 'Sometimes I found it ridiculous that my screen would disappear when I was trying to show people something on my computer' (Participant two). Similar sentiments were expressed by another administrator at the conclusion of the passive prompt period: 'A welcome distraction now, but at the start and sometimes now, I want to tell the Exertime man to bugger off (participant six). Together these comments reflect what is already known about the difficulty of changing habits when there is a need for an individual to exert effort in decision-making (Lally et al., 2010). This issue is a central issue for health researchers and professionals assessing the sustainability of workplace interventions. There appears to be a need to scaffold behavioural changes by educating employees about the difficulty of adopting new health behaviours.

Despite the finding that participants' experienced difficulties in adjusting to the new behaviour of increasing NEAT by interrupting POS, others proved more resilient and accommodating. In response to a perceived acute negative outcome (disruption to workflow) participants made changes to their work habits to accommodate a positive health behaviour (interrupting POS). Some participants reported that while they faced difficulties performing the new behaviour, after a period of time this became inconsequential. A community liaison officer remarked during the passive prompt period:

> After about four weeks or so, I got use to the way Exertime worked and in fact I found the regular interruptions a good thing. It helped me regulate my day at work, you know 45 minutes goes so fast. I use the 45 minutes to get my work completed and then I take a break. (Participant 13)

These comments reflect that after a short adjustment period the regular interruptions stimulated a positive response: the incentive to complete work. A forensic-based officer said after the passive prompt period, 'Despite my frustrations, I eventually adapted the way I work. I became more conscious of my time and how to structure my work output' (Participant 11), and a clerical-based support officer stated during the passive prompt period: ‘I now religiously get up as soon as I have to use the photocopier, collecting printing, and filing. I just always took the easier option before and waited until the end of the day’ (Participant 33). Several participants were able to make the disruption of the prompt a welcome part of the workday, and subsequently carried out work-related tasks while standing and moving.

Other participants indicated an inability to accommodate change (*n* = 2) and found the intrusion caused by the passive prompt to be extreme. A problem arose when, during the fourth week of the passive prompt period, the TDPEM updated its operating software, leading to a conflict with the Exertime code. The problem was rectified within a week, but such a disruption introduced an unplanned occurrence that might adversely affect adherence and participants’ perceptions of the intervention. Although the two distressed participants adhered to the intervention for the 13 weeks of passive prompting, they decided at that time to remove the software. One, a clerical assistant, declared:

> Never again. I hated the program. It locked my computer up when I needed to speak on the phone, too many interruptions. There was some problem with our computers and it just crashed. It eventually worked when they fixed the software but I don’t want it again. (Participant 29)

This comment illustrated that the frequency and repetitiveness of the passive prompt appearing on the computer screen became a point of frustration, and developed a negative association between the program and interruption. This revealed that not all participants found the intervention to be a positive addition to the workplace environment, and could have a lasting and negative impact on perceptions of workplace interventions, POS and movement.

Category: workplace climate. A recurring experience recounted by a majority of participants (*n* = 10) was a change in the immediate workplace climate. Participants noted that this change was with direct work colleagues and supervisors. Participants noted that they felt at ease being away from their personal workstation during the intervention and did not have the usual sense of being under surveillance. An administrator working in a multiple person group environment recalled after the active prompt period:

> I don’t feel guilty about being away from the desk any more. Like it’s become normal to be up during the day. People expected you to be sitting all day. Now it’s accepted that I can be up and moving. (Participant 20)

Another officer working in community liaison duties said at the conclusion of the active prompt period:

> I now feel comfortable leaving my chair; it has now become a routine and accepted. A great addition to a call centre. We always have breaks but now people who have the program seem to be standing up more regularly. We keep our headsets on but we stand and do the exercises that are appropriate. (Participant 13)

Desk-based employees in a variety of occupations in different organisations commonly feel that if they are not seated at their workstation then they are not working. Time spent away from this position is often viewed as a lack of productivity and time wasting, particularly by managers and administrators. The comments above reveal how these participants found the intervention to provide pragmatic endorsement and justification for interrupting POS and moving away from the workstation, relieving some of the indirect pressure to remain seated, and changing the workplace climate to endorse the new behaviour.

Surprisingly, the decision to participate was influenced by a state-wide parochial competition between the geographically separated police stations that appeared to stimulate incentive in some participants. One administrator explained during the passive prompt period, 'Can't say I was really interested but when I talked to some southern people skiting about how fit they are I signed up' (Participant six). A sworn officer recalled, following the active prompt period, 'You know there is always a deal of competition between the north and the south. I wanted to be part of that. Can't have those southerners boasting about how good they are' (Participant 25).

Several participants indicated that the inclusion of many other TDPEM locations throughout the state acted as a source of motivation and an incentive to engage. This sense of competition indirectly created a climate of unity and pride among participants who worked closely, and possibly added to any individual benefits gained from being involved in the study.

Category: social interaction. I noted that part of the perception of change in workplace climate included evidence of an increase in social interaction within and between work groups. Some participants worked in larger groups (more than 10 employees) and a number in smaller work groups, so it was interesting that there was an increase in social interaction in different group sizes. The social outcomes varied from an increase in verbal communication and conversation between participants about being exposed to the intervention to non-participants adopting increased levels of movement. Following the passive prompt period an administrator stationed in a small office environment composed of individual work cubicles said:

> When I started to do the activities, colleagues asked me about them and why I was doing them. Some colleagues started to get interested and even though they didn't have the program, they did the exercises with me. We all have a laugh when we do them, but the others wanted to find out about other exercises, and it now gives us something more to talk about at morning tea. We often remind

> others about having to walk the stairs because we have been eating biscuits at the break. (Participant six)

A front office receptionist remarked after the active prompt period:

> The program has definitely brought us closer together as a staff group. It has great social benefits. We laugh and talk about the exercises. We talk about the guy who does some of the exercises within the software program. My office colleague and I have a system whereby I lead an exercise on all the even hours and she leads an exercise on all the uneven hours throughout the day. (Participant 43)

A clerical-based officer remarked about the passive prompt period, ‘Each time me and the other ladies in this office area get up and exercise together. It’s a giggle but we support each other’ (participant 33). Other participants disclosed that the increase in social interaction influenced their commitment to the intervention. The building of interaction between participants built commitment and a sense of belonging to a group or an intervention. A community support officer explained following the active prompt period:

> I was a little hesitant at first. You know, I was all of a sudden standing up doing these exercises. People wanted to know why I had a step at the photocopier. I was a little self-conscious but as people asked about what I was doing, and they understood, they became involved. That seemed to make things easier. You know, like keeping going for 13 weeks. (Participant 22)

Increased social interaction extended to changes in communication within work groups. An administrator continued this after the active prompt period:

> The program has created great social benefits especially for us who use stairs. I regularly see and speak with other employees who I would not normally

> communicate with. I now go out of my way to go and collect mail or collect guests from downstairs so that I can meet with these colleagues. (Participant 20)

There also seemed to be an increased sense of belonging, brought about through participation in the intervention. A forensic-based officer remarked at the conclusion of the active prompt period:

> I have this sense of an increase belonging because it gives me something to talk to others about. We have something in common. I share my efforts with others when I talk to them. It's something I share with others when we meet. I work largely by myself, so there is a sense of being by yourself but I feel like I'm part of something bigger now. (Participant 12)

Taking these data as a whole, it seems that the introduction of NEAT movement to the workplace had an outcome of bringing work colleagues closer together, contributing to a sense of meaning and belonging to a work group. Participants saw themselves as more than employees who worked on the same floor: they became a group who supported each other through the intervention. Moreover, engaging in NEAT movement provided participants with a shared direction regarding a collegial approach to improving health at the workplace, and through this shared direction fostered increased interaction among the participants.

Outcomes at the Exosystem Level

Several participants (n = 6) indicated that the workplace intervention had an outcome at the organisation level: an increased level of awareness of the health of desk-based employees, and an enhanced awareness of the risks associated with their work design and function. A sworn officer, after the active prompt period, said,

> Nobody ever talked about prolonged sitting as a health risk before now. The term Exertime is almost like Google. Everyone talks about it and the benefits that it

> has on health. Desk-based workers are conscious that there are risks within their working environment. Senior management is supportive in alleviating that risk. We want everyone to have access to it. (Participant 25)

The education of the participants about POS fostered their recognition that a need for health behaviour change existed; and this need was complemented by the software program periodically reminding the participants of behaviour change. The statement made by Participant 25 that ‘we want everyone to have access to it’; indicated that the sustainability and long-term benefits of the program were recognised.

A senior administrative support officer commented at the conclusion of the active prompt period:

> This program has changed a lot of people’s perceptions of what we have to do. There is more to health than the 30 minutes of activity. This program has sent a message that sitting is a possible risk factor. We have always looked after our staff but more so the frontline. Now we are doing something to help our administrative staff. We recognise that we have to mitigate the risk. Senior management are right behind this intervention. It’s a good news story because it’s preventative and all-inclusive. (Participant eight)

Participants also reported an increased perception related to organisational concern and willingness to act on health concerns. This perception developed through frontline staff taking an active interest in the health of employees’ at all organisational levels. A sworn officer commented following the passive prompt period, ‘We sometimes get the feeling that it’s all about frontline staff. They need help but my health is also important. This intervention is the first thing that they have done that targets us. That’s good’ (Participant four).

Results from the semi-structured interviews show that participant health behaviour was influenced at the microsystem, mesosystem and exosystem levels of the social ecological framework (Bronfenbrenner, 1992; Sallis et al., 2006). Participants expressed that their concepts of interrupting POS and moving now included aspects of enjoyment, freedom, increased motivation and feelings of success. The intervention was effective in increasing awareness about sitting habits, and this knowledge encouraged them to modify their behaviour, leading to the development of a health habit of frequent interruptions to sitting. This interview data provided support that the 13-week passive prompting intervention was enough to instigate behaviour change in terms of reducing POS, although more qualitative evidence is required to establish if the behaviour change is sustainable.

Themes emerging from the interviews following the 13-week passive prompting period indicated that the intervention instigated sustainable behaviour change. Collectively, the emergent themes demonstrated that a 13-week passive prompting period was effective in instigating sustainable health behaviour change, with a reduction in POS being the catalyst to such change.

The qualitative measure of the semi-structured interviews enabled me to verify that the participants had increased their awareness of the risks associated with POS, and their responses to literature driven questions indicated that their workplace health behaviour had been changed through exposure to the passive prompting intervention. The qualitative interview data substantiated what the self-reported measures of health and frequency of participation compliance revealed over the research period, offering deeper understanding by deciphering perceptions at set times throughout the research period. Overall, the qualitative data aligned most closely with the self-reported health data in that the intervention improved participant health over the 26-week research period. There is also resonance of the qualitative data with the results from the compliance data, implying that multiple participants require a passive prompt to maintain health behaviour change.

Study Limitations

There are several limitations to this study. Notwithstanding the positive changes in perceptions of health reported by participants, the absence of a control group does limit the validity of the findings. The adoption of an action research approach was intended to identify whether POS behaviour and NEAT were influenced by the intervention. Beyond this intention, the intervention was constructed to encourage desk-based employees to embrace desirable behaviours (Anshel & Kang, 2008); this method did not require a control group. Despite the limitations associated with the non-existence of a control group and an action research approach, there were significant improvements in values reported for total health, physical health, and mental health categories from pre-test to post-test, and lasting effects of these improvements were evident. There is the possibility that after the first 13 weeks of the study the POS habit had changed in participants and the software became redundant as the new habit of interrupting sitting replaced the old behaviour. A low number of participants in the study sample, and the use of self-report measures to evaluate health and compliance are recognised as limitations to this study. Follow-up studies should incorporate a larger sample size and use more direct measures of compliance such as accelerometers to deliver real-time objective data.

Future Research

Collecting data on the sitting, standing, and ambulatory behaviours of populations who spend excessive time sitting is important when assessing their health as individuals and as groups. As the number of occupations that are dominated by sitting increases, there is a need to develop methods and interventions to diminish POS and incorporate regular movement into every workplace environment. Although this study adopted an action research approach, the self-reported perceptions relating to health and compliance are pertinent. Future studies examining the efficacy of passive or active interventions tested on an experimental group in comparison to a control group may provide empirical findings that can be generalised to widespread populations. In addition, comparing a passive intervention with an active intervention in independent groups may provide insight into which approach has the greatest impact in terms of encouraging health behaviour change. To date the majority of workplace interventions to reduce prolonged sitting have been measured on a short-term basis, limiting the testing of factors of longevity and of intervention sustainability. More investigation into the elements of workplace interventions that contribute to improving health that are sustainable is warranted, such as user-control engagement, use of the workplace environment as a facilitator or barrier to health, and implementing regular short-duration movement.

Outcomes derived from the qualitative evaluation in this study indicate that participants' decisions to engage with an intervention are subject to features such as the uniqueness of the intervention, their freedom to control interaction with the intervention, and, in choosing activities, the adaptability of the activities to required times and intensity, and a sense of play. In this study, providing a mechanism for brief bouts of NEAT activity that were integrated into daily work routines and were appropriate for the built environment proved effective. Future workplace interventions should consider such an approach in preference to more traditional approaches, to allow non-exercisers to build confidence and change their POS habits. Perceived organisational competition between individuals and geographical groups appeared to be a source of motivation and promoted social interaction within the workplace, and incorporating this into workplace interventions might assist in attracting initial interest and encouraging adherence.

Future studies should consider adopting a mixed methods approach to capture participants' perspectives that cannot be discovered through quantitative methods. A strength of the mixed methods approach adopted in this study was that multiple sources of data collection were compared and analysed to detect trends or patterns. Incorporating an interview structure at various time points enabled perspectives on behaviour change to be monitored periodically, and offered the chance to evaluate behaviour change in both the short- and long-term intervention.

Chapter 5

Conclusion

The purpose of this thesis was to evaluate the effectiveness of a workplace intervention designed to interrupt POS and increase short bouts of NEAT, to reduce the health risks associated with POS. To accomplish this, desk-based employees were exposed to a workplace intervention which periodically prompted them to interrupt their POS by standing and performing workplace movement. The premise of this research was constructed upon evidence from the past decade demonstrating that populations such as desk-based employees spend the majority of the workday seated (Evans et al., 2012; Pronk et al., 2012; Thorp et al., 2009), with the primary consequence being an absence of movement in the workplace environment. A growing body of research advising that POS can adversely impact indicators of health such as cardiovascular disease, blood lipids, waist circumference, muscle activation and life expectancy (Dunstan et al., 2012; Hamilton, Hamilton, & Zderic, 2007; Healy et al., 2011; Katzmarzyk et al., 2009; Owen et al., 2010) drove the research questions for this research. To provide insight into the efficacy of interrupting POS to reduce the health risks associated with the behaviour, multiple dependent variables were investigated and presented in two studies, Study A and Study B. Two separate cohorts of participants were recruited from a state wide Tasmanian organisation which employed a large percentage of full-time desk-based employees in a variety of occupations. This chapter reports the conclusions and recommendations derived from the results reported and the associated findings from Study A and Study B.

Study A focused on addressing Research Question 1: Can a workplace intervention designed to interrupt prolonged occupational sitting improve the health of desk-based employees? A large body of research advocating numerous adverse health effects associated with prolonged sitting informed the research question. A novel intervention featuring a passive prompt was used to interrupt POS and increase NEAT movement in a cohort of desk employees over 13 weeks, with favourable results found for energy expenditure and MAP. The increase in energy expenditure demonstrated that the passive prompt was effective in interrupting the POS behaviour of study participants, and provided the stimulus for brief bouts of NEAT to be performed throughout the workday. When engaging with the intervention, participants interrupted POS and stood for close to eight minutes by engaging in short bouts of NEAT activities over six times per workday, a duration of just under one and a half minutes of work time for each activity. This finding indicates that workplace behaviour can be changed by short duration periodic movement rather than solely through participation in common dose-response continuous physical activity, such as 30 minutes of moderate-to-vigorous activity. The introduction of POS interruptions and NEAT activities to workplace interventions aimed at sedentary workers offers a feasible approach to increasing energy expenditure and improving health.

Increasing energy expenditure through engagement with the intervention impacted positively on participants’ MAP levels. Moreover, interrupting POS and performing short bouts of NEAT periodically throughout the workday beneficially impacted MAP. This is an exciting result, as to date there is little evidence to support the effectiveness of short bouts of movement on MAP, or on systolic and diastolic blood pressure. A large body of research does exist identifying the benefits of continuous physical activity on blood pressure (Cornelissen & Smart, 2013; Fagard & Cornelissen, 2007), but to my knowledge this is the first study to establish a link between periodic standing and moving with the health outcome MAP. The MAP finding reported in Study A sheds new light on exercise routines, and the approach utilised in Study A offers an achievable method to reduce blood pressure among broad populations who are habitually sedentary. The decrease in MAP demonstrates that complementary to the broadly recommended and endorsed guideline of 150 minutes of physical activity per week (Department of Health and Aging, 2012), interrupting POS with standing and performing NEAT may have a similar physiological effect. Considering that 32 per cent of the Australian population are hypertensive (Heart Foundation, 2012), and with the growing number of workplaces and occupations that are dominated by tasks undertaken while sitting, the rationale for changing workplace behaviour and improving employee health outcomes is warranted. Although not measured in this research, it is possible that the decreased MAP levels could have been influenced by a decline in participants' stress levels, as research has demonstrated that occupational stress can adversely affect blood pressure (Light et al., 1992; Schnall et al., 1992; 1998). In Study B several participants commented that engagement with the intervention removed them from the workstation and provided a mental break and a feeling of refreshment, thus it is possible that individual stress may have reduced, contributing to the drop in MAP. The decrease in MAP was a key finding from Study A and confirmed that the intervention had a positive physiological effect.

Despite the MAP result, engagement with the intervention did not change the blood glucose, cholesterol, or triglyceride levels of the participants. Between pre-test and post-test, the results for each of these physiological biomarkers showed minimal change, suggesting that interrupting POS and increasing NEAT over 13 weeks was not enough to influence these variables. A body of research ion the literature emphasises that prolonged sitting has a negative impact on blood glucose, cholesterol, and triglyceride levels (Dunstan et al., 2010; Healy et al., 2011, 2012; Henson et al., 2013), with the commonly suggested approach to lowering these biomarkers being regular bouts of continuous physical activity combined with nutritional changes. The findings from Study A indicate that more than periodic NEAT movement is required to modify blood glucose, cholesterol, and triglyceride levels of desk-based employees, providing endorsement of the recommended physical activity guidelines of 30 minutes of moderate-to-vigorous physical activity on most days. However, it may be that the 13-week research period was too short to register the intervention’s effect on blood glucose and blood profile levels. In Study A the results for these physiological biomarkers may have been limited by the small sample size, and statistically limited by the small range of figures reported for each measure. This lack of movement, suggesting that the intervention failed to have a physiological impact other than on MAP and bringing into question whether the intervention did improve the health of desk-based employees, triggered the focus for Study B.

A strength underpinning the intervention used in Study A was that it was predicated on social ecological grounds (Bronfenbrenner, 1992). Interventions constructed on a theoretical approach have a significant impact on participants, achieving greater levels of adherence and sustainability of behaviour change sustainability than other methods (Glanz & Bishop, 2010). The social ecological approach in this case was effective in influencing how the participants engaged with the workplace physical environment, and changed their POS and movement behaviour in the workplace. A benefit of this behaviour change was that elements which had previously been viewed as barriers to movement became enablers of movement. An example of this is employees commonly choosing to take the elevator instead of the stairs: participants exposed to the intervention in Study A regularly used the stairs to increase their activity levels and take a break from sitting.

The aim of the intervention was not merely to force participants to stand and execute movement during the workday. Considering that once prompted passively the participants had no choice but to engage with the intervention, such a view does hold some legitimacy; but workplace interventions designed to increase physical activity have largely been unsuccessful (Chau, 2009; McGillivray, 2002). A primary reason for this lack of success and the reluctance of people to change their health behaviour is that participants must consciously make a decision to engage with the intervention. This is characteristic of active prompts such as posters encouraging employees to take the stairs rather than the elevator, or information brochures put on notice boards, newsletters, and staff desks advocating the health and economic benefits of parking a distance from work and walking further. In this study participants involuntarily engaged with the intervention, but retained they control over the intensity and duration of each engagement. These factors were voluntary.

The aim of Study B was to further address the impact of the intervention on the health of a cohort of desk-based employees, but also to examine if interrupting POS and increasing NEAT was effective in initiating workplace health behaviour change, and if so, if it was sustainable. Previous research in this field has demonstrated a pattern of positive health behaviour change over a short period (four to six weeks), but over a long period (12 weeks or more) participants tend to return to the behaviours observed prior to the intervention (Chau, 2009; Leslie et al., 2005; McGillivrary, 2002). In Study A it was evident that health behaviour change was initiated over the 13-week period, but the parameters of the study precluded following up to see if there was any lasting effect. Against this background Research Question 2 was developed: Can a workplace intervention designed to interrupt prolonged occupational sitting instigate and maintain health behaviour change in desk-based employees? To address this, a mixed methods approach was designed. Cresswell and Plano Clark (2007) have asserted that when the strengths of both quantitative and qualitative data are combined, a unified and fuller comprehension of research problems is achieved, beyond that of either approach alone. An action research methodology was also adopted, underpinned by a communitarian model (Forster, 1982) to provide a platform for the achievement of the goal of reducing POS by interrupting desk-based sitting and incorporating NEAT into the workday. As the intent was to gain insight into the effectiveness of a workplace intervention to change participants' POS behaviour, no control group was required. Study B was different from Study A in two major respects: the first that the research period was 26 weeks; the second that for the first 13 weeks of the study the intervention featured a passive prompt (as in Study A), but in the second 13 weeks this was removed and replaced by an active prompt.

The SF-36 self-report health inventory was used to measure participants' perceptions of health at pre-test, post-test (13 weeks), and second post-test (26 weeks). This approach was used to gather data on the health of the participants throughout the research period following the mixed health results reported in Study A, and the associated ease and convenience of using self-reported methods in a large organisation across multiple locations. Following initial pre-test results where the participants reported health levels similar to that of the national average (Butterworth & Crozier, 2004), perceptions of health increased significantly at the 13-week post-test. As the intervention was grounded on periodically interrupting sitting to perform short bouts of NEAT, a significant increase in health was a notable finding. Crucially, the second post-test at 26 weeks revealed that participants' perceptions of their health were maintained after the passive prompt feature had been removed. This implies that the passive prompt, which was functional in the first 13 weeks, was successful in improving health levels and had a lasting impact on how participants felt about their health. It could be contended that the passive prompt was effective in creating a wanted habit in the participants, and this habit continued to endure without the passive prompt being present.

To enhance the validity of findings on access to and engagement with the intervention, and its ability to foster sustainable behaviour change, participants completed a self-report feature of each time they activated the program, interrupted POS and performed a bout of NEAT. These data were collected for both the passive and the active prompt periods. More interruptions to POS were executed during the passive prompt period, such that the passive prompt improved the odds of the participants engaging with the intervention every hour nearly five times over the active prompt. During the active prompt period participants continued to use the intervention, but with considerably less regularity. This finding demonstrates that for desk-based employees to consistently engage in standing and moving, a stimulus that involuntarily engages them in the decision-making process is substantially more effective that an active stimulus that is voluntarily initiated. Essentially, when the decision to interrupt POS was initiated not by the participants but by the program, participants followed the prompt. When they were required to make a decision to interrupt POS, they were less likely to do so. A passive stimulus produces more sustainable health behaviour change than an active stimulus.

The lack of congruence between the self-reported perceptions of health and the self-reported frequency of participation data presented a problem for study B. The increase in health reported in the passive prompt period was reflected in engagement with the intervention, and the results demonstrated that many of the participants achieved a level of compliance by performing seven or more NEAT activities per day. Perceptions of health remained high in the active prompt period, but recorded compliance to the intervention was considerably lower than in the passive prompt period. The conflict between these data and the associated results suggests that an intervention featuring a passive prompt is enough to initiate and maintain perceptions of health, but not enough to maintain health behaviour change. A possible explanation for this disparity is that participants continued to interrupt POS and perform NEAT but did not activate the software program on their computer, so that their sessions went unrecorded. The new behaviour was thus continued in an involuntary, unconscious, and automatic fashion, indicating that a habit had been developed (Aarts & Verplanken, 2000), and that there was no need for these participants to log activity data. In addition, when the prompt appeared passively it encapsulated a large part of the computer screen and could not be ignored, and the participant had to either engage with the program or return to work. The active prompt was smaller and displayed permanently on-screen, and could be ignored. These variations in how participants were prompted had the potential to affect how they interacted with the intervention, particularly during the active prompt period.

In addressing Research Question 2, semi-structured interviews were conducted with 15 participants three times during the research period, to capture the lived experiences of the participants and to evaluate the effectiveness of the self-report measures used in Study B. Literature-driven themes were identified based on Bronfenbrenner’s theory (1992), and findings suggested that participants’ workplace health behaviour was influenced at the microsystem, mesosystem, and exosystem levels. At the microsystem level participants raised the topic of play in that the intervention fostered feelings of enjoyment, motivation, and success. A theme of the development of a health habit was also apparent at this level, with all participants indicating that their workplace sitting and movement behaviour had been modified through interaction with the intervention. Interestingly, the effect of the intervention on nutritional habits, leisure time physical activity, smoking and weight were not intended outcomes of this study, but presented as emergent themes during the interviews.

At the mesosystem level the intervention enhanced participants' social interaction, facilitating collegiality by interrupting POS and performing NEAT to the extent that colleagues who were not part of the study joined in. Participants felt comfortable standing and leaving their workstation for a physical and mental break: a change in workplace climate that they had not previously experienced. The qualitative data revealed that social interaction increased as a result of the intervention and participants became closer, embracing communitarian values to support the common good. In this case the common good was interrupting POS and engaging in short bouts of NEAT movement, often carried out collectively. According to Forster (1982), a communitarian model emphasises commonality, inclusiveness, cooperation, solidarity and community as ends in themselves rather than as an instrument for achieving individual ends. Interrupting POS and interacting with the workplace physical environment created a shared, communal approach to individual and collective health among the employees.

Despite the affirmative comments reported by the participants regarding the intervention, the majority of participants revealed that in the first four and six weeks of passive prompts hindered their work flow and created a distraction. After this time nearly all participants reported that it was no longer a distraction, and that being prompted to stand and move had become part of their day. Several participants made changes to their work habits to adapt to the POS interruptions, and after a period of time they became of no consequence to work behaviour or performance. Some participants did report that the prompt caused frustration, and that they experienced difficulty in adjusting to their computer screen being taken over. At the conclusion of the 13-week passive prompt period, two participants still found the passive prompt intrusive, and at the end of the 26 weeks did not wish to retain the intervention software. The rather dejected comments by some participants about initiating and maintaining the behaviour change suggest that it might be valuable to provide specific education when introducing such a change to a workplace.

At the exosystem level of Bronfenbrenner's model (1992) the interviewees said that they believed their health was valued and appreciated in the workplace. The intervention was effective in creating an awareness of the number of hours that they actually spent seated at work, and provoked a reduction in POS through regular interruptions. The intervention was operative in getting the participants to cognitively assess their health behaviour at work and, through consistent exposure to the prompt, to modify their behaviour. It is likely that the education component of the orientation session prior to each study also had an impact on how participants viewed POS, workplace physical activity, and ultimately their responses towards both of these. Considering that the orientation session incorporated an explanation of the negative health effects associated with POS, the assumption that this instruction informed and modified workplace health behaviour can be made.

The semi-structured interviews confirmed several aspects of the effectiveness of a workplace intervention designed to instigate and maintain health behaviour change in desk-based employees. First, all the interviewees remarked that interacting with the intervention improved their health. This aligns with the health improvements self-reported at post-test and again at second post-test. Second, several participants stated that to continue with workplace health behaviour they required a passive prompt. This correlates with the data on the frequency of self-reported participation, which clearly indicates that a passive prompt was more effective than an active prompt in achieving compliance. Third, in spite of the affirmative nature of the qualitative data presented in Study B, not all participants were partial to the intervention, the manner in which it functioned, and its effect on the performance of various tasks; they did not wish to engage with it after the research period. This is unsurprising in relation to the acceptance of health interventions in general, but the qualitative data provided insight into the elements of the intervention that caused concern. Finally, comments from some participants indicated that after approximately four weeks of being exposed to the intervention, interrupting POS and performing movement became part of the workday and less of a distraction. This is valuable feedback and might provide a useful approach when educating participants prior to adopting or changing health behaviours.

Recommendations for Improving this Research

1. Self-report measures were used in this research to collect data on occupational physical activity levels (Study A), perceptions of health and compliance to the intervention (Study B). Previous research investigating self-reporting has revealed that people commonly over-report or overestimate their performance in relation to the variable being measured (Warren et al., 2010). Although the results for occupational physical activity and perceptions of health reported statistically significant differences between pre-test and post-tests, it should be noted that these findings were based on self-reports. To eliminate any uncertainly regarding these findings, participant education in the use of specific self-report measures would have been effective.
2. Measuring the dependent variables investigated in Study A and Study B over a longer research period, such as six or 12 months, would have been beneficial. Such extended time frames may facilitate the identification of particular behavioural patterns and determinants of behaviour through long-term exposure

to the intervention. Principally, a longer research period would have allowed for increased precision in drawing conclusions related to sustainable behaviour change through exposure to an intervention.

3. To reliably reflect the populations employed in desk-based occupations, increasing the sample sizes of both Study A and Study B would have been advantageous. In Study A minimal movement was exhibited for the physiological variables blood glucose, cholesterol, and triglycerides between pre-test and post-test. A larger sample size might have increased the chances of finding a statistical significance in one or more of these variables, and also could have expanded the scope of the research beyond one organisation.
4. Absenteeism through sick leave and annual leave affected the quantitative objective measures performed in Study A. Only 27 of the 46 participants provided results for pre-test and post-test blood pressure (MAP), and only 29 for blood glucose, cholesterol, and triglycerides. Although sick leave cannot realistically be prevented, obtaining information about participant leave prior to conducting Study A and eliminating those concerned from the participants might have prevented such a drop-off in recorded measurements for these variables.
5. Participants in Study A, from both the experimental group and the control group, underwent the orientation session, after which the participants from the experimental group received the intervention. The control group were asked to continue their workplace behaviour as before. A possible effect of this is that control group participants may have felt disappointed, finding the wait of 13 weeks to access the intervention frustrating. Furthermore, it might have served to inhibit them from volunteering for future intervention and research opportunities. A solution to this would be to provide the control group with the orientation

session at the conclusion of the research period, at the time they were given access to the intervention. Following the orientation session in Study A the control group decreased their workplace energy expenditure between pre-test and post-test over a 13-week period.

Recommendations for Future Research

Decreased prolonged sitting. There is a need for interventions that focus on reducing prolonged periods of sitting in a variety of environments. In modern society sitting is ubiquitous; at work, at home, when travelling, during meal times, at school. Time is spent in environments where being seated is the only option available, so that habitual sitting behaviour becomes the norm and health suffers. Recent research conducted by Buckley et al. 2015 provided specific recommendations for reducing sitting in the workplace. The findings from Study A and Study B in this thesis endorse these recommendations, advocating that daily sitting be interrupted briefly each hour. In addition, research conducted by Neuhaus et al. (2014) found that work stations that permitted activity and movement (by reducing sitting time) were effective in improving employee health without jeopardising work productivity and performance. Despite the current research not investigating work productivity, the findings from Study A and Study B support those reported by Neuhaus et al. (2014), and provide further awareness that changing workplace sitting behaviour is essential for employee health. Interventions that regularly interrupt sitting and initiate the development of an wanted habit are an achievable response to curbing customary sitting time. Future studies could examine decreasing prolonged periods of sitting as a primary outcome, as there is little evidence on the effectiveness of interventions to accomplish this.

Creating an active workplace environment. Workplaces and employee occupations are becoming less active (Thorp et al., 2012; van Uffelen et al. 2010). With increasing reliance on technology such as computers, forms of electronic communication, desktop photocopiers, printers, and telephones—all useable in the comfort of an office chair—employees are vulnerable to POST and its associated negative health effects. A direct result of the rise in employee POS is the removal of movement and energy expenditure during the workday to the extent that workers have no need to stand to perform any duties. A common perception held by many in society is that physical activity needs to be a 30 minute moderate-to-vigorous continuous bout performed daily to yield any health benefit. The findings from this research demonstrate that health outcomes can be achieved by regularly interrupting POS and performing a short one- to two-minute bout of NEAT. Furthermore, these findings have the capacity to inform occupational health and safety guidelines for desk-based and sedentary employees to create a more active and healthier workforce. New and innovative methods need to be developed to consistently detach desk-based employees from their chairs and move around. Importantly, techniques should target populations who are recognised as being most in need of improving their health, not only those who are already physically active.

Social ecological model as a research framework. The adoption of an intervention predicated on a social ecological model proved effective in changing the health behaviour of participants. Central to the behaviour change was that perceived barriers to interrupting POS and moving actually became enablers. The intervention influenced participants at the microsystem level, and both participants and many elements of their physical and social environment at the mesosystem and exosystem levels. Future studies and interventions that aim to change human behaviour should consider utilising a social ecological model to engage and retain participants. Modifying how people interact with and within environments that they commonly inhabit, at multiple levels of influence, also warrants further examination.

Incorporating an education component within interventions. All participants were exposed to an orientation session prior to the commencement of the studies in this research. Part of the orientation session included education on the negative health effects associated with POS, in conjunction with an introduction to the 65 NEAT activities available on the intervention software. Although the role of this education was not directly measured, participant interviews revealed that the participants had been largely unaware of the negative health effects of POS and had not given thought to performing physical activity at work. Few were aware of how long they remained seated without interruption, suggesting that time can pass unnoticed when sitting and working. It is likely that the education component of the orientation session contributed to the health behaviour change observed by the participants in this research, as energy expenditure, MAP and perceptions of health all improved. The role of education necessitates further investigation in such cases, as it offers a simple, inexpensive and effective method to inform populations about how health can be improved. It can provoke behaviour change. There is a modest amount of evidence to support the role of education in changing sitting behaviour, but best practice has not yet been established.

Passivity and user control lead to behaviour change. Using the desk-based computer as the mechanism to engage with the intervention was successful in reaching the participants and inciting behaviour change. Integral to the effectiveness of the intervention was the passive prompt feature which appeared on the computer screen involuntarily, removing the individual’s need to decide engage with the intervention. Once participants engaged with the prompt they had control over what they did and for how long, but first they were passively engaged in the process. The majority of interventions designed to change health behaviour use an active prompt so that participants choose when to engage with it, and when to ignore it, so the capacity of a passive prompt to promote and manufacture health behaviour change warrants greater investigation. Premised on eliminating the conscious decision-making process but complemented by allowing user-control, the intervention in this research instigated health behaviour change at the individual level, which over time had a communitarian effect on colleagues and the workplace. This change was not maintained when passivity was removed and participants were exposed to an active prompt.

Sustainable behaviour change and the role of habit. There is a need for health interventions to be implemented and measured over a long period. Many studies have investigated the efficacy of health interventions over short periods such as four, six, or eight weeks, but these offer limited proof of methods which lead to sustainable behaviour change (Leslie et al., 2005; Pressler et al., 2010). Currently little is known about the sustainable effects of interventions of longer than six months, and even less for intervention effects of over 12 months. Health behaviour change specific to the workplace, POS, and physical activity do need to be changed in many organisations, but it must be sustainable over the long term. One variable which relates to the adoption of a new behaviour and the decline of a previously observed behaviour is that of habit. The study of habitual behaviour, and its potential connection with adherence or resistance to a new behaviour might provide insight into the determinants of sustainability, and merits greater exploration.

A mixed method research design. To deliver study results that are valid, reliable and meaningful, a variety of approaches to collecting data is advantageous. The vast majority of studies investigating workplace sitting behaviour and physical activity behaviour have been either quantitative or qualitative, but not both. To generate a greater understanding of the impact that interventions designed to reduce sitting have, I advise the adoption of a mixed methods approach. Empirical evidence that addresses research questions and adds to the broad field of health research, and a mixed methods approach offers a comprehensive and thorough mode to construct research and establish research objectives.

The design of two studies to address Research Questions 1 and 2 in this thesis allowed for the unification of multiple dependent variables to evaluate the effectiveness of a workplace intervention to improve health and change health behaviour in desk-based employees, using separate cohorts of desk-based employees. Study A investigated five different dependent variables using a self-report of energy expenditure and a battery of objective measures to measure physiological biomarkers. Study B examined two dependent variables using a self-report for perceptions of health and a self-report for compliance with the intervention, along with qualitative interviews to allow triangulation of data. Collectively the variables measured allowed a thorough exploration of an interactive workplace intervention. Across Study A and Study B the combination of dependent variables investigated provided the structure for a mixed method approach, placing emphasis on developing a comprehensive understanding of the impact a workplace intervention had on the POS behaviour of a cohort of desk-based employees. I was determined to make a valuable contribution to the health literature through this research, and believe that the approach used reflects a contemporary approach to the human and social science fields.

Appendix A

Social Science HREC (Full Application)

Tasmania Explore the possibilities	**HUMAN RESEARCH ETHICS COMMITTEE**	UTAS

Important: Please send an electronic copy of this application (may be unsigned) and all attachments by email to Marilyn.Knott@utas.edu.au. All electronic copies should be submitted as Microsoft Word documents. A signed hard copy must also be sent to: Marilyn Knott, Private Bag 1, Hobart, 7001

If you have any questions, please call: 6226 7479

1. Title of proposed investigation
Please be concise but specific. Titles should be consistent with those used on any external funding application. **Project PAUSE: Physical Activity Using Short-burst Exercise**

2. Expected commencement date:	**Expected completion date of project**
January 2010	December 2010

3. Investigators:
CHIEF INVESTIGATOR (Note: This is the researcher with ultimate responsibility for the project. The CI may not be a student)

Given Name	Surname
Dean	Cooley

Staff Position: Lecturer **Qualifications:** Ph.D.

Staff ID: 02026409

School & Division: Education – Human Movement

Contact Address: Locked Bag 1330

Telephone: 3096 **Email:** Dean.Cooley@utas.edu.au (Required)

A. CO-INVESTIGATOR(S)

i) Given Name	Surname
Scott	Pedersen

Staff Position: Lecturer **Qualifications:** Ph.D.

Staff ID: 02410482

Contact Address: Locked Bag 1330

Telephone: 3554 **Email:** Scott.Pedersen@utas.edu.au

(Required)

ii) Given Name **Surname**

Staff Position: ______________ **Qualifications:** ______________

Staff ID: ______________

Contact Address: ______________

Telephone: ______________ **Email:** ______________
(Required)

C. STUDENT INVESTIGATOR(S):

i) Given Name **Surname**

Gender: ________ **Date of Birth:** ________ **Preferred Title:**
Mr / Ms / Miss /Mrs /Dr

Student Number: ______________ **Level**:
Undergraduate / Hons / Masters /
POSgraduate Diploma / PhD

Contact Address:

Telephone: ______________________ **Email:** ____________________
(Required)

ii) Given Name **Surname**

Gender: __________ **Date of Birth:** ____________ **Preferred Title:**
Mr / Ms / Miss /Mrs /Dr

Student Number: ________________ **Level**:
Undergraduate / Hons / Masters /
POSgraduate Diploma / PhD

Contact Address: ____

Telephone: ______________________ **Email:** ____________________
(Required)

4. Is this a student project that requires School approval (E.g. program of study approval)?	Yes ☐ No ☒

If yes, the project has been:

a)	Submitted	☐	*i)*	Approved	☐	*ii)*	Not yet approved	☐
b)	Not yet submitted	☐						

5. Approvals from other Departments / Institutions	
Does this project need the approval of any institution other than the University of Tasmania and/or the Department of Health and Human Services (e.g., Department of Education, particular wards in hospitals, prisons, government institutions, or businesses)? No ☒ Yes ☐ *If yes,* please indicate below the Institutions involved and the status of the Approval. Name of Other Institution(s):	Status:
Does this project need the approval of any other HREC? No ☒ Yes ☐ *If yes,* please indicate below which HREC and the status of the application. Other HREC(s): Status:	

6. Is the investigation a follow-up of a previous study?	Yes ☐ No ☒
If yes, what is the ethics reference number of that study? What was the title of that study?	

7. Funding

Under the National Statement (2.2.6) a researcher must disclose:

- *the amount and sources or potential sources of funding for the research; and*
- *financial or other relevant declarations of interest of researchers, sponsors or institutions*

Is this research being funded? Yes ☐ No ☒

If yes, please detail amount and source of funds (NS 5.2.7)

If this application relates to Grant(s) and/or Consultancies, please indicate the Title and Grant Number relating to it

If no external funding has been obtained, please indicate how any costs of research will be met:

The chief investigators and Tasmania Police will jointly apply for funding through the Department of the Premier and Cabinet for money from the Public Health and Wellbeing Project.

Do the investigators have any financial interest in this project? Yes ☐ No ☒

If yes, please give details

8. Keywords Please provide definitions for any technical terms and acronyms

Term	Lay Explanation
Exertime	Our primary experimental intervention. The time an employee takes from their workday to undertake incidental, short-burst exercise.
Incidental exercise	Short bouts of exercise (less than 5 minutes) performed throughout the workday to increase daily energy expenditure without having to schedule in an actual exercise session each day.
Sedentary behaviour	Behaviour characterized by long term sitting or to taking little exercise.

9. Rationale and Background for the Project:

Has the research proposal, including design and methodology, undergone a peer review process? Yes ☒ No ☐

If yes, provide details: This application has been reviewed by the Faculty of Education.

Please give a plain English description of the aims of this study.

The aim of this study is to test the efficacy of a work-based incidental exercise program (Exertime) that is initiated by computer-based video prompts. The goal of Exertime is to increase the daily energy expenditure in police officers with sedentary job descriptions.

Please give a plain English description of the justification for this study.

There is general agreement that participation in physical activity yields beneficial public health outcomes [1]. Yet, there is still disagreement regarding the dose-response effect of physical activity and changes in health status, either measured or self-reported [2]. In some instances, the recommendations follow the pattern of at least 30 minutes of moderate intensity exercise three or more times per week being the bedrock dose [3]. What is evident in the data since 1995 is that there is a difference between fitness and fatness [4]. In ongoing studies [4-7], individuals who are fat -- whether measured by body mass index, or a more direct measure of body composition such as skinfold or underwater weighing - and are also fit do not have a substantially elevated risk of mortality. In fact, they have a much lower mortality risk compared with lower- or normal-weight individuals who are sedentary [8]. These data have lead researchers, such as Blair [9], to advocate a rethinking of the physical activity message. As such, there is a call for the inclusion of increased incidental activity into everyday work and life [10-12], with as a key intervention in the fight against obesity [13, 14].

Blair [9] purports that even minimal activity may be better than no activity at all. He and others maintain that humans have essentially engineered energy expenditure out of their daily life at work, at home, and in recreational activities; and it is this change that has driven energy expenditure in daily life downwards. For example, people tend to use the remote control instead of getting off the couch to change television channels. It's easier to microwave a dinner than chop and stir and mix and cook. Work by Levine and others [13, 14, 16-18] suggests that the energy "cost" of this type of mechanization is approximately 100 to 200 calories daily. Research shows that people do not get the recommended dose, there are still benefits. For example, recent research [15] suggests that benefits accrue even at reduced dose levels. In a five year study involving a group of sedentary POSmenopausal women with moderately high blood pressure who completed exercise activity at different dosage levels, women who received only half the recommended dose demonstrated some significant physiological signs (e.g., blood pressure, HDL/LDL ratios) of improved health.

Moreover, it appears the "couch potato" concept applies to more life situations than just at home. Preliminary evidence [10, 15, 19-22] shows that an extremely sedentary life, in and of itself, is potentially harmful, and that the harmful effects may be additive. Even a daily bout of running or some other exercise may not entirely eliminate the harm if people spend the rest of their time in sedentary activity (i.e., sitting at work). Data from animal (rats) and human-based experiments [20] reveals that being kept immobilized results in 27 percent lower levels of lipoprotein lipase (LPL) compared with levels seen in routine sedentary living. Exercise raises

LPL levels, which in turn helps the body eliminate triglycerides. High triglyceride levels are associated with atherosclerosis and increased risk of heart disease. People who go from a routine sedentary existence to including a 30-minute daily run get a 22 percent increase in LPL. So, popping up and down during the day — for example, getting up from your desk every hour and taking a two-minute walk — may provide additional benefits to the daily dose of moderate-intensity exercise. So it appears that moderate levels of activity, spaced over a day, rather than given in one dose may be beneficial.

Current public health campaigns to decrease comorbid health conditions (i.e., obesity and type 2 diabetes) have largely focused on increasing exercise, but have paid little attention to the reduction of sedentary behaviours through increasing the frequency of incidental exercise at work. Moreover, most literature is limited to reports of changes in physiological measures such as blood chemistry (HDL/LDL, triglycerides) and cardiovascular fitness based on participation in traditional based physical activity interventions (i.e., 10 000 steps). The public health burden of a sedentary lifestyle has been recognized globally, but until recently, the prevalence and impact of the problem has not been studied in a uniform and systematic fashion.

Regardless of the aforementioned, the dose and frequency debate is null and void if people do not change their sedentary behaviour to a more active behaviour mode. Aarts and Dijksterhuis [24] theorise that individuals' choice to engage or not engage in exercise behaviour is initially explained by theories associated with reasoned action [25]. Nonetheless, as exercise participation is repetitive in its nature, it becomes a habit. Habits are characterised by strong associations between goals and actions that develop as a result of frequent and consistent choices made to attain a certain end-state. As a result of these associations, habitual choices and actions are automatically triggered upon the activation of the relevant goal or end-state. Likewise, satisfactory experiences enhance the tendency to repeat the same course of action, due to a stronger association. Thus, once individuals decide to be sedentary and this course of behaviour develops a strong association with outcomes, individuals are unlikely to alter their decision-making process. A large body of work [26-28] indicates that people are likely to alter their behaviour if they are prompted to re-engage in the deliberate decision making process. For example, research shows that if people re-engage in deliberate decision making about taking the stairs rather than taking the elevator at work through prompts, there is an increase in the odds of a change in pedestrian mode [26].

In light of the aforementioned findings, the present project was designed to determine the effects of a prompted incidental exercise at work intervention on the energy expenditure levels of a population of sedentary employees. Based on the research [29-31], it appears that a simple increase in incidental activity at work is a potential low cost health intervention that may have moderate effects on health. Moreover, research findings [26-28] indicate that a prompted message strategy may increase the odds of sedentary office workers changing to low intensity behaviour modes.

Please list the most relevant and recent literature references, both by the investigator and/or by others, that support the justification for the study.

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10. Participants

Number of Participants

How many participants do you intend to recruit?

30

Provide justification for the number of participants you intend to recruit.

As the primary purpose of this study is to pilot the Exertime intervention, the sample size will be ideally kept to a small number to maximise the ability of the researchers to control the intervention. Thus, in the considerations of statistical power, selected 95% confidence intervals will be quite wide. Nonetheless, the researchers will set alpha at 0.05 to detect a 5% change in the dependent measures.

Selection of Participants

Clearly describe the experimental and, where relevant, control groups. Include details of sex, age range, and any special characteristics (ethnic origin, demographic details, health status etc). Give a justification for your choice of participant group(s).

Tasmania Police and the UTAS Faculty of Education have recently formed a research partnership to implement this study. Approximately 30 participants (male and female) will be randomly selected from a pool of adult sworn and unsworn police officers employed with Tasmania Police who have indicated willingness to participate in this study. These 30 participants will be randomly assigned to either an experimental group or an in-waiting group. Participants in the in-waiting group will serve as controls for experimentation, and then will be offered the experimental treatment once the first phase (13 weeks) of experimental procedures have been completed.

Recruitment to this study will be criteria-based. First, Tasmania Police will identify suitable worksites. Second, participants will need to be free from morbidity and neuromuscular conditions. Third, participants will need to be ready to engage in behaviour change. Thus, they will need to be in one of three (contemplation, action, or relapse) of the five stages of behaviour change.

Will the project involve any of the following participants? Please note that any random sample of the population may possibly include all of these participants, unless the study has been designed to specifically exclude a particular type of participant.

			Yes	No	Possibly
(a)	Pregnant Women?	(NS 4.1)	☐	☐	☒
(b)	Minors, i.e. children under 18 years of age?	(NS 4.2)	☐	☒	☐
(c)	People highly dependent on medical care who may be unable to give consent?	(NS 4.4)	☐	☒	☐

(d)	People with a cognitive impairment, an intellectual disability, or mental illness?	(NS 4.5)	☐	☒	☐
(e)	People who may be involved in illegal activities?	(NS 4.6)	☐	☒	☐
(f)	People in other countries?	(NS 4.8)	☐	☒	☐
(g)	Aboriginal and Torres Strait Islander peoples?	(NS 4.7)	☐	☐	☒
(h)	People who are identifiable by their membership of a cultural, ethnic or minority group?		☐	☐	☒

For each "Yes" or "Possibly", show how your research complies with the relevant section in the *National Statement*.

If you answered "Yes" to (g) you must also attach a statement indicating how Aboriginal and Torres Strait Islander sensitivities will be recognised (see the following publication for guidance: http://www.nhmrc.gov.au/publications/synopses/e52syn.htm)

Statement 4.1.1 will be adhered to by screening potential participants with the PAR-Q and thereby ensuring medical permission is provided by the participants' medical practitioner. This research does not target Aboriginal and Torres Strait Islander communities or groups; however these peoples may work at a selected worksite and therefore would be privy to the inclusion of our study (Statement 4.7.1). Data analysis does not include differentiation on the basis of cultural, ethnic, or minority groups (Statement 4.7.1).

Recruitment of Participants

How will participants be recruited? From where will your participants be recruited?

Give specific details about how participants will be recruited. Some questions to consider include:

- Are you recruiting through advertisements? If so, indicate where they will be placed and append a copy

- Are you recruiting through 3rd parties like associations, schools or clubs? If so, detail how you will approach the organisations and the process that the stakeholders will use to pass on information to potential participants. Please attach copies of letters of introduction, emails, and telephone preambles if appropriate
- Are the participants University or DHHS staff, or regular patients in a particular clinic? If so, detail how they will be approached i.e. through personal invitation, email etc.

Figure 1 below represents Phase 1, the recruitment process. The UTAS research team (URT) will be responsible for publication of all information material. The URT will distribute study information brochures (Appendix A) to the Tasmania Police Manager of Occupational Health and Safety for Tasmania Police (TPMOHS). The TPMOHS will be responsible for identifying the worksites that will be targeted for participation in the study. The TPMOHS will distribute information brochures to the employees at these worksites who will be instructed to respond by email to the TPMOHS if they are interested in taking part in the study. URT will provide the consent package (Appendix B) to TPMOHS, who will distribute to the identified individuals.

Individuals who wish to participate in the study will complete, sign, and date the consent form and two preliminary questionnaires (Physical Activity Readiness Questionnaire and Stages of Change Questionnaire) and return all forms to the URT. After a period of 14 days, the TPMOHS will send a bulk reminder email to all individuals urging the return of the consent form package. All individuals will be given a coded number to use throughout the study. The URT will have access to the list of matched numbers and names of participants. All participants will use the coded number on questionnaires and as a password to the screensaver.

The URT will be responsible for identifying the sample population using the selection criteria. Selection criteria for this stage of the recruitment process is (a) a signed consent form, (b) no contraindications identified on the PAR-Q questions, and (c) the individual in one of the three identified stages of change (contemplation, action, or relapse). Individuals who do not meet one of these selection criteria will be sent a letter (Appendix C) informing them of their non-selection in the study and thanking them for their interest.

(continued)

Individuals who meet the selection criteria will be recruited into the study sample by random selection. The random selection machine will ensure a stratified sample by gender. Individuals not selected into the study population will be sent a letter indicating that they have not be selected into the initial study population, but if a participant drops out of the study, they may be selected as an replacement (Appendix D). Individuals selected into the study will be sent a letter by the URT identifying their selection and outlining the procedures of the study (Appendix E).

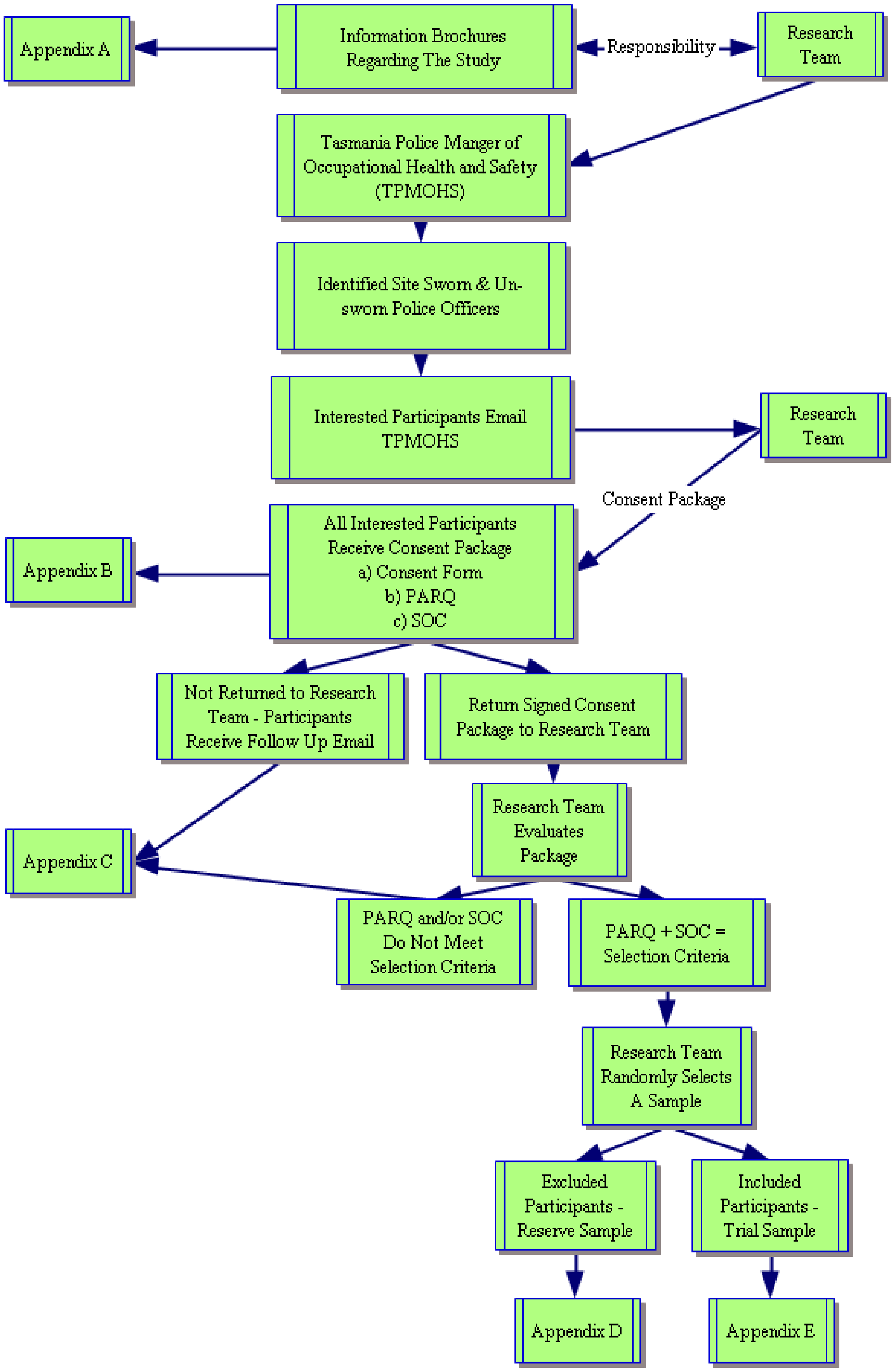

Figure 1: Phase 1 – The Recruitment Process

11. Data Source and Identifiability

Does the project involve information sourced from databanks?	(NS 3.2)	Yes ☐	No ☒

If yes, state which one(s) and indicate what permission for access is required. Include a description of any conditions of access and attach any relevant approvals.

Is the data collected about individual participants:

a) Non- identifiable?

Non-identifiable data is data which have never been labelled with individual identifiers or from which identifiers have been permanently removed, and by means of which no specific individual can be identified. A subset of non-identifiable data are those that can be linked with other data so it can be known that they are about the same data subject, but the person's identity remains unknown. ☐

b) Re- identifiable?

Re-identifiable data is data from which identifiers have been removed and replaced by a code, but it remains possible to re-identify a specific individual by, for example, using the code or linking different data sets. ☒

c) Individually Identifiable?

Individually identifiable data is data where the identity of an individual can reasonably be ascertained. Examples of identifiers include the individuals name, image, date of birth or address, or in some cases their position in an organisation. ☐

12. Federal Privacy Legislation

The following questions are part of the requirements concerning federal privacy legislation.

(a) Is this project medical research (including epidemiological research?)	Yes ☐	No ☒	
			Go to (b)
If yes, will you require the use or disclosure of information from a Commonwealth agency?	Yes ☐	No ☐	
If yes, will the information to be disclosed be personal information, i.e. identifiable information?	Yes ☐	No ☐	
If yes, will you be obtaining consent from the individuals to whom the information relates?	Yes ☐	No ☐	
(b) Is this Research relevant to public health or safety, or to the management, funding or monitoring of a health service?	Yes ☐	No ☒	
			Go to (Qn 13.)
If yes, does the research involve the collection, use or disclosure of information from a private sector organisation?	Yes ☐	No ☐	
If yes, will you be collecting, using or disclosing health information	Yes ☐	No ☐	

If yes, will consent be obtained from the individuals to whom the health information relates?	Yes ☐ No ☐

13. Procedures

Describe the procedures to which participants will be subjected or the tasks they will be asked to carry out (please detail exactly what you will be doing).

This investigation will utilize a pre-POS1-POS2, crossover treatment research design as depicted in figure 2. After an initial screening for study inclusion (Phase 1), all participants randomly selected for groups 1 and 2 will undergo assessment at baseline, after the first 13 weeks of treatment, and after the second 13 weeks of treatment. Phase 3 and Phase 4 will serve as the treatment periods for Groups 1 and 2, respectively. In Phase 4 for Group 1 and Phase 5 for Group 2, the 13 weeks will constitute a washout period, respectively. This washout period will allow the UTR to assess the long-term effects of Exertime to change sedentary behaviour.

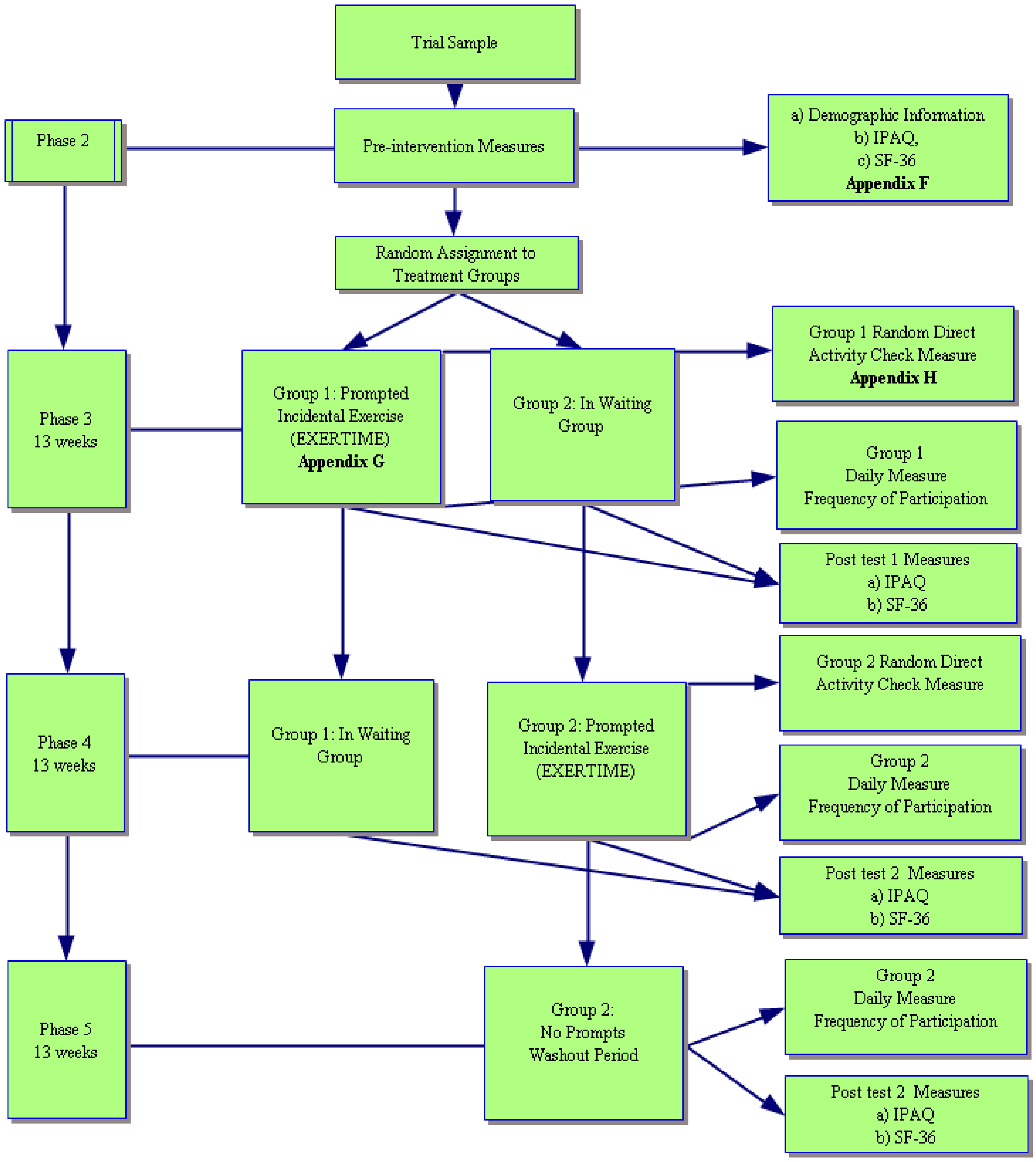

Figure 2: Phases 2-5 – The Experimental Design

Phase 2 Pre-Intervention Measures

All participants will complete basic demographic questions (Appendix F) and baseline assessment measures for the main dependent variables in the study: IPAQ and MOS-SF36 (Appendix F).

After completing Phase 2, participants will then be randomly assigned to one of the two groups. Group 1 will be the experimental group for the first 13 weeks, and Group 2 will serve as controls in the in-waiting group for the first 13 weeks. These two groups will switch assignments for the second 13 weeks of the study. POS-test 2 will occur 13 weeks after the Exertime intervention for both groups 1 and 2.

Phase 3 Treatment Plan (13 weeks):

Group 1 will self-monitor energy expenditure levels while receiving a computer-based prompted incidental physical activity program (Exertime) for the first 13 weeks of treatment (Appendix G). Group 1 will self-report daily participation in activities through the computer software that will be uploaded on their work computer by the TPMOHS. Group 2 will serve as an in-waiting control group during this time period. Participants in Group 2 will be asked not to instigate any new activities during this time. Group 2 participants will not be exposed to Exertime.

During Phase 3, participants in Group 1 will receive a telephone call from the URT to validate their recording of their daily participation in physical activity using suggested Exertime activities. The URT will follow a telephone prompt script designed to ensure participants are accurately reporting their participation (Appendix H Part A). Participants in Group 2 will receive a similar call but with an emphasis on ensuring that participants have not engaged in new activities (Appendix H Part B). The URT will perform random activity checks by phoning participants to inquire about possible overestimation of activity self-reporting. This will allow us to perform an error estimate in our data analysis. For group 2 the Random activity checks will allow us to monitor changes in physical activity status.

At the completion of week 13, both groups will complete the IPAQ and MOS- SF-36.

Phase 4 Treatment Plan / Washout Period 1 (13 weeks):

Phase 4 will serve as the crossover period, thus Group 2 will be exposed to the Exertime intervention and Group 1 will cease exposure to the Exertime intervention. Under the new group assignments. Procedures will replicate those in Phase 3.

Phase 5 Treatment Plan (13 weeks):

Phase 5 will serve as the washout period for Group 2. This will allow both groups 1 and 2 to have a 13 week washout period of no Exertime intervention so that the UTR can measure the long-term effects of the Exertime intervention.

Experimental Treatment: Exertime Group

The intervention for this study is a computer generated prompt that reminds participants to perform short-burst physical activities (Exertime) throughout the workday. This innovative work-based exercise program is engineered to place small increments of physical activity back into work life. The software is loaded onto computers (either stand-alone or intranet based), with the interface being a screen saver. The screen saver is time generated to appear on the user's computer after a set period. For example, if an individual has accumulated 30 minutes of typing or computer based time, the screen saver will appear automatically. Thus, individuals will be engaged in no more than 16 minutes of activity spaced over an eight hour working day. The user has the option of either rejecting the exercise suggestion or participating in the Exertime. If the user selects to do Exertime the screen saver will then randomly select a short video of a work-based exercise option for the user. The user then performs the activity (either for the recommended dose or a self-selected dose) and then records this using an interface on the screen saver. The screen saver will log the user's frequency of activities and dose throughout the workday. The user can then check their progress via the screen saver. Exertime activities will fall into three exercise categories: chair exercise, office exercise, and facility exercise. Example Exertime activities include:

Knee Lifts (Chair Exercise)

Sit in your desk chair with good POSure and your back against the chair back. Grasp your chair with both hands and slowly bring your knees up to your chest. Then lower your legs back to the normal sitting position. Record the number of repetitions.

Push Throughs (Chair Exercise)

Sit off the side of your desk chair with your legs together raised in the air. Grasp the edges of your chair with each hand. Extend your legs straight out and lean your back at a 45 degree angle. To pull in, bring your knees in toward your midsection, and your torso towards your legs creating an abdominal crunch. To relax, push your legs out straight again at the same time tilting your back to the starting position. One crunch equals one repetition. Record the number of repetitions. Make sure your abdominals are doing the work in a slow and controlled fashion.

Chair Squats (Chair Exercise)

Stand in front of your desk chair with your feet shoulder-width apart. Bend your knees and slowly squat towards the chair. Either hover just over your chair or sit for a second, then fully extend your legs until you're back to the standing position. Repeat. Record the number of repetitions. Don't hunch over, keep your back straight.

Wall Sits (Office Exercise)

Stand with your back leaning against a wall. Slide down until your knees are at about 90-degree angles and hold. Keep your abdominals contracted and your hands at your sides. Or you can read the newspaper? Record the time you were able to maintain this position.

Stork Stands (Office Exercise)

Don’t have the time to work up a sweat? Work on your balance. Stand comfortable on both feet with your hands on your hips. Lift one leg and place the toes of that foot against the knee of the other leg. Now raise the heel of your standing foot and stand on your toes. Balance for as long as possible without letting either the heel touch the ground or the other foot move away from the knee. Record the time you were able to maintain your balance. Repeat using your other leg.

Step ups (Facility Exercise)

While you are waiting next time at the copy machine do some exercise. There is now a small bench next to the copy machine…a great opportunity to do some step ups. Perform an alternating up and down stepping movement pattern. Step-up with right foot, then with the left foot. Step-down with right foot, then with the left foot. Mix it up…get creative. Record the number of repetitions.

Stair Climb (Facility Exercise)

If your office has a set of stairs, take the stairs instead of the lift. In fact, when you get to the top, come back down and do it again. What a great way to burn calories in a short amount of time. If you are short of breath when you get to the top, march in place or walk around for a couple of minutes. Record the number of stairs you climb each day. Stairs are everywhere!

Toe Raises (Facility Exercise)

Stand with the balls of your feet on a stair, midfoot and heels over the back edge, feet pointing straight forward. Slowly raise your heels over the step, and then lower them below the step. Repeat. Record the number of repetitions. Try them with your toes pointing inward. Then try outward. Mix it up.

Wall Touches (Facility Exercise)

Stand facing a wall with your feet shoulder-width apart, bend your legs just a bit and jump up and tap the wall at arm’s length. Repeat. Try to get higher on the wall each time. Record the number of repetitions.

Take a Hike (Facility Exercise)

When we are in the office we tend to do a lot of sitting. Mix it up. Take spontaneous laps around your desk. Got a little extra time? Take a lap around your corridor. Record the number of desk laps and corridor laps you complete in a day.

Take a Roll (Facility Exercise)

Sit in an office chair with wheels on a flat floor surface. Pull yourself across the surface using only your legs. This is a great hamstring workout. Record your steps as repetitions. Perhaps your office mates would like to organize an "office chair slalom race" like they did at MIT:

http://www.ai.mit.edu/lab/olympics/97/chair.html

In-Waiting Group: Controls

Group 2 will serve as a control-in waiting group for the initial 13 weeks of treatment, but will then become the experimental group and receive the Exertime treatment during the second 13 weeks of treatment. While serving as the control group participants will agree to not participate in any new form of work-based physical activity.

<u>Assessment Tools</u>:

International Physical Activity Questionnaire (IPAQ)

The International Physical Activity Questionnaire (IPAQ) is the most feasible instrument for measuring physical activity in large groups or populations. The change in engagement in physical activity will be assessed by energy expenditure as measured by the IPAQ (Appendix F, questions 1 – 27). The IPAQ was developed to measure health-related physical activity (PA) in populations by estimating energy expenditure. The short version of the IPAQ has been tested extensively and is now used in many international studies. Research for reliability and validity shows that the IPAQ has strong positive relationships with low PA ($rho = 0.55$, $p < 0.001$) and vigorous PA ($rho = 0.71$, $p < 0.001$), but somewhat weaker relationship for moderate PA ($rho = 0.21$, $p = 0.051$).

Medical Outcomes Survey – Short Form 36 (MOS-SF36)

Increasingly researchers have recognised that self-report measures of health related quality of life are an effective means of evaluating exercise based interventions. Health related quality of life measures allow individuals to self-report perceived changes across a range of measure including physiological, emotional, social, and mental. In this study the MOS-SF36 will serve as a measure of change in participants' quality of life (Appendix F - questions 28 – 52). The MOS-SF36 is a reliable and valid instrument that is used internationally to assess interventions. For example across various samples test-retest intraclass coefficients for a 10-day interval were in the range 0.65 to 0.79, with *Cronbach alpha coefficient* results indicating good internal consistency (range 0.70 to 0.89).

(continued)

Direct Measures of Physical Activity

The number of logged Exertime activities will be utilised as a direct measure of changes in physical activity. This measure will accumulate every day and be logged for each individual through the screensaver.

Hypotheses:

H_0: The Project PAUSE incidental physical activity intervention (Exertime) will not significantly increase energy expenditure (IPAQ score), will not significantly increase perceptions of health-related quality of life (MOS-SF36 score), and will not significantly change sedentary behaviour in participants.

H_1: Increasing the frequency of participation in incidental physical activity of police officers will result in significant improvements in their level of energy expenditure (IPAQ score) compared to control participants not exposed to the Exertime intervention.

H_2: Increases in incidental activity by police officers exposed to the Exertime intervention will significantly improve perceptions of health-related quality of life (MOS-SF36 score).

H_3: The Exertime intervention will significantly increase participation (logged Exertime activities) in incidental physical activity in the workplace.

Data Analysis:

As the primary purpose of this study is to pilot the Exertime intervention, the sample size will be restricted to maximise the ability of the researchers to control the intervention. Thus, in the considerations of statistical power, selected 95% confidence intervals will be quite wide. Nonetheless, the researchers will set alpha at 0.05 to detect a 5% change in the dependent measures.

Dependent variables include energy expenditure (IPAQ score), self-reported health related quality of life (MOS-SF36), and the number of logged Exertime activities. Independent variables are group (experimental, control), testing session (pre, POS1, POS2). Group will be tested for significant differences as a between factor, and testing session as a repeated measures factor. Reliability estimates using intraclass correlation coefficients will be calculated for each of the dependent measures based on the levels of each independent variable. Pearson product moment correlations coefficients will be conducted to determine what relationships exist between the dependent variables. If high correlations (r = > 0.60) exist between the dependent variables, these data will be analysed inferentially using a multivariate analysis of variance (MANOVA), with an *a priori* alpha level of 0.05. If dependent variables do not correlate (r = < 0.60) univariate analyses of variances (ANOVA) will be conducted. Significant interactions will be further examined using simple effects analyses. POS hoc comparisons will be performed using paired sample *t*-tests (Seaman, Levin, & Serlin, 1991). Changes in the frequency of Exertime activities will be assessed within pre and POS periods using an odds ratio analysis.

14. Data				
Will photographs be taken?	Yes	☐	No	☒
Will video-recordings be made?	Yes	☐	No	☒
Will interviews or focus groups be tape-recorded?	Yes	☐	No	☒
If you answered “Yes” to any of the above, please describe the information to be collected.				

15. Disclosure and consent:				
Does the project collect information from which individual participants can be identified? (NS 2.2)	Yes	☒	No	☐

If yes, could the research be conducted using non-identifiable information? Yes ☐ No ☒

Does this project use any form of implicit or passive consent? (NS 2.2.5, 2.3) Yes ☐ No ☒

If yes, please describe how your research complies with the relevant section of the *National Statement*.

Will there be any deception of participations including concealment and covert observation? (NS 2.3.1, 2.3.2) Yes ☐ No ☒

If yes, please describe how your research complies with the relevant section of the *National Statement*.

Describe how participants will <u>consent</u> to participate in this study and how they will be informed of their rights (NS 2.2.1-2.2.7). Attach copies of your Information Sheet and Consent Form (where relevant) or give an explanation of the process by which you will obtain consent.

(*Proformas for Information Sheets and Consent Forms are available on our website at:*

http://www.research.utas.edu.au/human_ethics/social_science_forms.htm)

Participants will consent by signing a consent form and returning the consent to the URT. The consent form will contain information that outlines their rights associated with participating in the study. Tasmania Police's Manager of Occupation Health and Safety (TPMOHS) will distribute information and consent forms to all identified Tasmania Police worksites.

16. Reimbursement				
Is any reimbursement, payment, or other reward being offered to participants in the study? (NS 2.2.10)	Yes	☐	No	☒
If yes, please state what will be offered, what amount will be offered and for what purpose (e.g. a voucher as a prize, reimbursement to cover expenses etc).				

17. Intrusiveness				
Are there any aspects of the study that are intrusive in areas ordinarily considered personal and private, or that could create apprehension and anxiety for participants?	Yes	☐	No	☒
Are you collecting personal details or private information?	Yes	☐	No	☒
Is there any kind of dependency relationship between the researcher and any of the participants?	Yes	☐	No	☒
If you answered "Yes" to any of the above, please explain in more detail.				

18. Potential benefits, risks and harms (NS 2.1)

(a) What are the possible benefits of this research to:

(i) The participant?

Improved health status and education about the benefits of work-based physical activity programs.

(ii) The wider community?

Improved employee health.

(b) What are the possible risks or harms of this research to the participants? (NS 2.1)

Could your research evoke anxiety or lead to the recall of painful memories?	Yes	☐	No	☒
Will participants be asked to provide any information or commit any act, which might diminish self-respect or cause them to experience shame, embarrassment or regret?	Yes	☐	No	☒
Will any procedure be used which may have an unpleasant or harmful side effect?	Yes	☐	No	☒
Does the research use any stimuli, tasks, or procedures, which may be experienced by subjects as stressful, noxious, or unpleasant? (NS 2.1)	Yes	☐	No	☒
Will you induce or create physical pain beyond mild discomfort?	Yes	☐	No	☒

Are there any other possible risks or harms of this research to the participants?	Yes ☐ No ☒

If yes, please list other possible risks or harms.

If you answered yes to any of the above, please describe how your research will comply with the National Statement (2.1). In addition, please describe the process(es) you will use to manage possible risks (e.g. if interviews may cause distress, provide details of support processes that will be put into place).

19. Monitoring

What mechanisms do you intend to implement to monitor the conduct and progress of the research project? (NS 5.5)

The research team will conduct regular audits of worksites to ensure compliance with the prescribed research protocols.

20. Feedback

What feedback will be given to participants? How will feedback be given? (NS 1.5)

A summary of the data analysis will be disseminated to all individual participants and workplaces through a group seminar, with the possibility for individual follow-up consultations. Reports of the study will be presented at industry-based conferences.

21. Data Storage
Please state how and where your data will be stored, and for how long it will be retained. Address any issues of data security.
Please note: Data must be stored for at least five years beyond the date of publication and then destroyed. All data must eventually be destroyed, unless explicit consent has been obtain from the participants to archive their data.
All data will be stored on the chief investigator's computer in an encrypted security file. A copy of all data will also be stored on the associate investigator's computer using similar encrypted files. All raw data will be stored in a locked filing cabinet in the Human Movement administrative office. All digital data will be protected by encrypted password access only known to the research team. All data will be stored for five years beyond the date of publication of any results. All data will then be destroyed by security shredding and hard drive reformatting.

22. Other Ethical Issues				
Are there in your opinion any other ethical issues involved in the research?	Yes	☐	No	☒
If you answered "Yes", please explain in more detail.				

23. Declarations

a) Statement of Scientific Merit:

The Head of School or the Head of Department is required to sign the following statement of scientific merit:

"This proposal has been considered and is sound with regard to its merit and methodology."

The Head of School's or Head of Department's signature on the application form indicates that he/she has read the application and confirms that it is sound with regard to:

(i) educational and/or scientific merit; and

(ii) research design and methodology.

This does not preclude the SSHREC from questioning the research merit or methodology of any proposed project.

If the Head of School is one of the investigators, this statement must be signed by an appropriate person. This may be the Head of School/Department in a related area or the Dean. The certification of scientific merit may not be given by an investigator on the project.

Name

Position

Signature

Date

b) Conformity with the National Statement

The *Chief Investigator* is required to sign the following statement:

> I have read and understood the *National Statement on Ethical Conduct in Human Research 2007*. I accept that I, as chief investigator, am responsible for ensuring that the investigation proposed in this form is conducted fully within the conditions laid down in the *National Statement* and any other conditions specified by the HREC (Tasmania) Network.

Name

Position

Signature

Date

c) Signatures of other investigators

I acknowledge my involvement in the project and I accept the role of the above researcher as chief investigator of this study.

Name:	**Signature:**	**Date:**
Name:	**Signature:**	**Date:**
Name:	**Signature:**	**Date:**

CHECKLIST	
Please ensure that the following documents are included with your application:	
Information sheet/s (if not attached ensure you have explained why in Section 10)	☒
Consent form/s (if not attached ensure you have explained why in Section 15)	☒
Questionnaires (if applicable)	☒
Interview schedules (if applicable)	☒
A copy of any permissions obtained i.e. Other HREC, Other Institutions (if applicable)	☒
All documents relevant to the study, including all information provided to subjects.	☒
Telephone Preambles (if applicable)	☒
Recruitment Advertisements (if applicable)	☐
Email Contents (if applicable)	☒

TO SUBMIT THIS APPLICATION:

1. You must email an electronic copy of this application form (may be unsigned) and all study documents to Marilyn.Knott@utas.edu.au (please submit all forms as Microsoft Word documents)

2. You must also send a signed hard copy of this application form and all study documents to Marilyn Knott, Private Bag 1, Hobart, 7001

Has the 'Statement of Scientific Merit' been signed ☐

Have all investigators signed the form? ☐

Appendix B

Exertime Activities and Descriptions

Stand up and Type

Standing up and talking on the telephone

Take a phone call and type

Standing on alternative legs office hop scotch - pattern on the floor behind the desk

Front Raise to Triceps Press

Sit tall with the abs in and hold a full water bottle/book in the left hand. Lift the bottle up to shoulder level, pause, and then continue lifting all the way up over the head. When the arm is next to the ear, bend the elbow, taking the water bottle behind you and contracting the triceps. Straighten the arm and lower down, repeating for 12 reps on each arm.

Bicep Curl

Hold water bottle/ book in right hand and, with abs in and spine straight, curl bottle towards shoulder for 16 reps. Repeat other side.

Simulate jumping rope for a minute

Hop on alternate feet, or on both feet at once. An easier version is to simulate the arm motion of turning a rope, while alternately tapping the toes of each leg in front.

While seated, pump both arms over your head for 30 seconds, then rapidly tap your feet on the floor, football-drill style, for 30 seconds. Repeat 3-5 times.

Leg Lifts

At your desk, you straighten your knees and lift your legs out in front of you.

March with your feet in place while seated.

Calf exercises, raise your feet up on the toes and lower them.

Change to sitting on a stability ball for the next 15 minute

Seated Knee Hug

Sit on the edge of your chair with a tall spine.

Arms rest at your sides. Action: Exhale and bring the right knee upward, toward your chest, without rounding the upper body forward. The arms reach around and hug the right knee, adding a teeny bit more of a stretch to the lower back. Inhale and return the foot to the floor. Exhale and bring the left knee upward, toward your chest, without rounding the upper body forward. Hug your left knee with both arms, then inhale and return to the starting position. Do one set of 20 repetitions (10 per side).

Elevated push-ups

Lean on a sturdy piece of furniture and slowly push your body off of it in a sort of standing push up.

Hip flexions

While sitting in your chair, lift your right foot a few inches off of the floor. Keep your knee bent at a 90 degree angle and hold the position as long as you are comfortable

Wall sits

Rest your back against a wall and move your feet away from the wall. The wall should be supporting the weight of your back and your knees should be bent. Hold the position as long as possible.

Chair dips

Place the palms of your hands on your chair and your feet on the floor. Move your rear end off of the edge of your seat. Bend your elbows and lower your body. Straighten your arms to return to the starting position.

Knee Lifts (Chair Exercise)

Sit in your desk chair with good POSure and your back against the chair back. Grasp your chair with both hands and slowly bring your knees up to your chest. Then lower your legs back to the normal sitting position. Record the number of repetitions.

Push Throughs (Chair Exercise)

Sit off the side of your desk chair with your legs together raised in the air. Grasp the edges of your chair with each hand. Extend your legs straight out and lean your back at a 45 degree angle. To pull in, bring your knees in toward your midsection, and your torso towards your legs creating an abdominal crunch. To relax, push your legs out straight again at the same time tilting your back to the starting position. One crunch equals one repetition. Record the number of repetitions. Make sure your abdominals are doing the work in a slow and controlled fashion.

Chair Squats (Chair Exercise)

Stand in front of your desk chair with your feet shoulder-width apart. Bend your knees and slowly squat towards the chair. Either hover just over your chair or sit for a second, then fully extend your legs until you're back to the standing position. Repeat. Record the number of repetitions. Don’t hunch over, keep your back straight.

Wall Sits (Office Exercise)

Stand with your back leaning against a wall. Slide down until your knees are at about 90-degree angles and hold. Keep your abdominals contracted and your hands at your sides. Or you can read the newspaper? Record the time you were able to maintain this position.

Stork Stands (Office Exercise)

Don’t have the time to work up a sweat? Work on your balance. Stand comfortable on both feet with your hands on your hips. Lift one leg and place the toes of that foot against the knee of the other leg. Now raise the heel of your standing foot and stand on your toes. Balance for as long as possible without letting either the heel touch the ground or the other foot move away from the knee. Record the time you were able to maintain your balance. Repeat using your other leg.

Step ups (Facility Exercise)

While you are waiting next time at the copy machine do some exercise. There is now a small bench next to the copy machine…a great opportunity to do some step ups. Perform an alternating up and down stepping movement pattern. Step-up with right foot, then with the left foot. Step-down with right foot, then with the left foot. Mix it up…get creative. Record the number of repetitions.

Stair Climb (Facility Exercise)

If your office has a set of stairs, take the stairs instead of the lift. In fact, when you get to the top, come back down and do it again. What a great way to burn calories in a short amount of time. If you are short of breath when you get to the top, march in place or walk around for a couple of minutes. Record the number of stairs you climb each day. Stairs are everywhere!

Toe Raises (Facility Exercise)

Stand with the balls of your feet on a stair, midfoot and heels over the back edge, feet pointing straight forward. Slowly raise your heels over the step, and then lower them below the step. Repeat. Record the number of repetitions. Try them with your toes pointing inward. Then try outward. Mix it up.

Wall Touches (Facility Exercise)

Stand facing a wall with your feet shoulder-width apart, bend your legs just a bit and jump up and tap the wall at arm’s length. Repeat. Try to get higher on the wall each time. Record the number of repetitions.

Take a Hike (Facility Exercise)

When we are in the office we tend to do a lot of sitting. Mix it up. Take spontaneous laps around your desk. Got a little extra time? Take a lap around your corridor. Record the number of desk laps and corridor laps you complete in a day.

Take a Roll (Facility Exercise)

Sit in an office chair with wheels on a flat floor surface. Pull yourself across the surface using only your legs. This is a great hamstring workout. Record your steps as repetitions.

Perhaps your office mates would like to organize an “office chair slalom race” like they did at MIT: http://www.ai.mit.edu/lab/olympics/97/chair.html

Lower Body Exercises

Wall Squat-Thrusts

Lean into a wall with your hands and keep your feet shoulder width apart several feet from the wall. Slowly lift one knee up toward your chest and back and then the other leg. As you improve your fitness, increase your leg lift speed and move your weight onto the ball of the rear foot.

Tuck Jumps

1. This exercise is an advanced dynamic power move that should be done only after a complete warm up.

2. Stand with feet shoulder width and knees slightly bend

3. Bend your knees and descend to a full squat position.

4. At the bottom of the squat, powerfully explode straight up bringing your knees toward your chest while in midair.

5. Grasp your knees quickly with your arms

6. At the top of the jump your thighs should touch your torso.

7. Release your legs, control your landing and descend into the squat again for another explosive jump.

8. Upon landing immediately repeat the next jump.

9. Avoid doing these drills on concrete and use a soft, flat landing surface until you are comfortable with the exercise.

10. Use these drills no more than once per week to avoid overuse or excessive impact on your joints.

Backward Stride

Stand with feet together. Stride backward with one leg, while raising the arms to shoulder level. Lower the arms to your side and repeat with the other leg. Pick up the pace for more cardio.

Jumping Jacks

The basic jumping jack is a good cardio and strength training exercise.

Side Jumps

Stand with feet together. Jump to the right several feet, keeping knees bent and landing in a squat position. Jump back to the left and continue jumping from side to side. Use a small object to jump over if you like (book, pillow etc.).

Mountain Climbers

Start on your hands and knees and get into in a sprinter's start position. Keep your hands on the ground and push off with your feet so you alternate foot placement (run in place) as long as you can. Be sure to keep your back straight, not arched.

Wall Sit

With your back against a wall, and your feet about 2 feet away from the wall, slide down until your knees are at a 90 degree angle. Hold the position as long as you can. This is great for ski conditioning.

Jump Lunges

Start in the lunge position – one foot forward and one foot back. Bend your knees and then jump up high and switch leg positions. Use explosive, but controlled movements.

Squat-Thrusts

Stand with feet together. Squat down and place your hands on the floor next to your feet. In an explosive movement, jump feet backwards into a push-up position, jump feet back between hands and stand up.

Basic One Leg Squat and Reach

1. Place an object on the floor about 2-3 feet in front and to the left of your left foot.

2. Balance on your left foot; raise your right foot off the ground.

3. Slowly bend your left knee and lower your torso.

4. Reach forward with your right hand and touch the object.

5. Maintain your balance by extending your right leg slightly.

6. Be sure to keep your left knee over your left foot.

7. Touch the object, pause, and return to the start position.

8. Maintain a slow and controlled movement throughout the exercise.

9. Repeat the exercise 5-10 times. Switch feet and repeat on the other side.

10. Complete 2 sets.

Advanced One-Leg Squat-and-Reach

1. Because shoes offer additional support, you can increase the difficulty of this exercise by performing it barefoot. This engages the small muscles of the foot and ankle that stabilize the ankle and maintain balance.

2. You can also hold a small, 5-8 pound dumbbell in your hand as your reach forward and slowly reach out to the left as far as you can go, pause 3 seconds and then slowly return, switch hands and reach to the right.

3. Repeat 10-15 times on each side and switch to the opposite foot and hand.

4. Do 2 sets for each side.

Walking Lunge

Start at one end of the room and take a long stride forward with the right leg. Bend down so the forward knee is directly over the toes and at a 90 degree angle. Raise up and repeat with the other leg across the room.

Lunges

Stand with feet close together. Now step forward with one leg into a deep lunge, and keep the other leg straight. Push yourself back up and repeat with the other leg. Be careful not to let your knee go farther than your toes on the leg that lunges forward.

Boot-strappers

Get in a standard push up position. Now walk your hands back until they are about 2 and half feet in front of your toes (adjust accordingly for your body size). You are now in a "jack knife" position with legs straight. Now bend your knees until your butt touches your heels, arms are still straight. Straighten your legs and repeat continuously.

Exploding Star Jumps

Slowly lower yourself into a full squatting position. Now explode upward and forward as high, hard and fast as you can. As your body reaches its apex...extend your arms and legs into a "star" shape. Cushion your landing by flexing your knees, don't land with stiff legs. Go for quality, not quantity on these. Five to ten is plenty.

Stomping grapes

There are two variations to this movement, and you need both to get the entire benefit. First movement...stand with your legs together, and bring your knee as high as possible. Make sure you stand completely straight...the goal is to raise your knee and touch your chest. Alternate legs, repeatedly. Raise your leg with CONTROL, don't jerk it up and try your best to touch your chest at the top. Second movement...clasp your hands above your head as if you were being frisked by a cop. Now, raise your knee straight up to the side with the goal of touching your knee to the underside of the arm. Keep your body completely erect, and don't jerk the leg. If you are facing North, your knees and toes should be pointing due East/West when you do this movement. Try to attain/maintain this alignment and really explore the range of motion on this second version.

<u>Upper Body Exercises</u>

Chair Dips

You'll need two chairs, (or a bed and a chair or a counter, etc…) for this great tricep exercise. Place two chairs facing each other, about 3 feet apart. Sit on one chair with your hands palm down and gripping the edge of the chair. Place your heels on the edge of the other chair and hold yourself up using your triceps. Slide forward just far enough that your behind clears the edge of the chair and lower yourself so your elbows are at 90 degrees. Do as many repetitions as you can.

Push Ups

1. Get on the floor and position your hands slightly wider than your shoulders.

2. Raise up onto your toes so you are balanced on your hands and toes.

3. Keep your body in a straight line from head to toe without sagging in the middle or arching your back.

4. Your feet can be close together or a bit wider depending upon what is most comfortable for you.

5. Before you begin any movement, contract your abs and tighten your core by pulling your belly button toward your spine.

6. Keep a tight core throughout the entire push up.

7. Inhale as you slowly bend your elbows and lower yourself until your elbows are at a 90 degree angle.

8. Exhale as you begin pushing back up to the start position

9. Don't lock out the elbows; keep them slightly bent.

10. Repeat for as many repetitions as your workout routine requires.

Incline Push Ups

If a standard push up is too difficult, you can start by doing push ups against a wall, a table or a sturdy chair. Stand several feet away from the object you are using and use the same push up technique as above to lower yourself until the elbows are 90 degrees and then raise back up. Keep you core tight the whole time.

Bent Knee Push Ups

This is a modified version of the standard push up performed on the knees rather than on the toes. Be sure to keep the knees, hips and shoulders all in a straight line; most people have a tendency to bend at the hips as though you are bowing, but this is incorrect technique.

Decline Push Ups

This is a more difficult push up, performed with the feet raised up on a box or bench. You can adjust the box height to increase or decrease the resistance using just your body weight.

Clapping Push Up

This is a plyometric exercise in which you push yourself up with enough power so that your hands come off the floor and you clap in midair. This exercise is not for novice exercisers. You can get injured very easily if you haven't worked up to these one at a time.

Diamond Push Up

The diamond push up is done with your hands close together; with the index fingers and thumbs of one hand touching the other hand and making a diamond shape. You then do push ups with your hands touching the centre of your chest and elbows close to your sides during each rep.

Shadow Boxing

Assume the position and go for a little shadow boxing. It’s really a pretty decent way to get your cardio and strength work all at once. Focus on controlled movements (not flailing punches), stay light on the balls of your feet and keep your knees bent. Practice jabs and upper cuts and all your moves. Hold a couple bottles of water for more resistance.

Burpees

Start in a standing position with feet close together. Now, squat down and put the palms of your hands outside and slightly forward of your feet. With your weight supported by your hands, thrust your feet backward so that you are in the traditional "up position" for a standard push-up. Do a push-up and return to the up position. Immediately after the push-up, pull your feet up to your hands in one movement, and stand back up to the original position. This is one "rep".

Bear crawls

Get down on all fours and walk around like a bear. Do this for three to five minutes. You'll look like that kid from *The Jungle Book*.

Crab walk

You're on all fours, but this time you're facing upwards. Very awkward, and much more of a challenge to your coordination than the bear crawls.

Crocodile walk

You're face down again. This time the object is to crawl along the floor with your torso as close to the floor as possible without touching. It's hard to describe the leg/foot and arm/hand positioning. Just plop down and figure out what works for you. Track your progress by what distance you can cover.

The Deck of Cards

Get yourself a deck of shuffled cards. Very simple, black equals push-ups, red equals squats. Face cards are worth 10, the Ace is 1, and all other cards are face value. Turn over a card; it's the 9 of spades; do 9 push-ups. Immediately turn over the next card; it's the Queen of diamonds; do 10 squats. Keep going until you finish the deck. The goal is to finish the deck in 12 to 15 minutes.

Core Exercises

Basic Abdominal Crunch

Lie on your back, bend your knees, placing your hands on the sides of your head.

Contract your abs and flatten your lower back against the floor.

Slowly lift your shoulder blades one or two inches off the floor.

Exhale as you lift, keep your neck straight and chin up.

Hold for a few seconds (don't hold your breath).

Slowly lower while keeping your abs contracted.

Repeat.

Reverse Crunch

Lie on your back with your hands out to your sides, knees bent, and feet on the floor. Bring your knees up towards the chest so they bend about 90 degrees. Contract your abs and lift your hips off the floor in a very small movement (don’t rock). Hold one second, lower, and repeat.

Bicycle Crunch Exercise

Lie flat on the floor with your lower back pressed to the ground.

Put your hands beside your head.

Bring your knees up to about a 45-degree angle and slowly go through a bicycle pedal motion.

Touch your left elbow to your right knee, then your right elbow to your left knee.

Breathe evenly throughout the exercise.

Vertical leg crunch

Lie on your back and extend the legs up with knees slightly bent.

Contract your abs and raise up until your shoulder blades leave the floor.

Keep your chin up; don't pull on your neck.

Keep your legs in a fixed position.

Lift your torso toward your knees.

Lower and repeat for 12-16 reps.

Long Arm Crunch

Lie on your back with your arms over your head with hands clasped and arms close to your ears.

Keep your knees bent with feet flat on the floor.

Contract your abs and lift your shoulder blades off the floor.

Lower and repeat for 12-16 reps.

Plank (Hover) Exercise

Start in the plank position with your forearms and toes on the floor.

Keep your torso straight and rigid and your body in a straight line from ears to toes with no sagging or bending.

Your head is relaxed and you should be looking at the floor.

Hold this position for 10 seconds to start.

Over time work up to 30, 45 or 60 seconds.

Plank with Leg Lift

Start in the same plank position as above with your forearms and toes on the floor.

Slowly raise one leg 5-8 inches off the floor (photo 2)

Count to two and slowly lower your leg to the floor.

Switch legs and repeat. Do 2-3 sets of 10 reps.

Plank with Arm Lift

Start in the same plank position (photo 1) as above.

Carefully shift your weight to your right forearm.

Extend your left arm straight out in front of you.

Hold 3 seconds while keeping your core tight.

Slowly bring your arm back to starting position.

Switch arms and repeat. Do 2-3 sets of 10 reps.

Modified Plank with Leg Lift

To make this exercise a bit easier, you can perform the movement on your hands, rather than your elbows.

Supermans

Lie on your stomach with your arms and legs stretched out. Raise your arms and legs off the ground a few inches, hold a few seconds, and then lower. Alternate arms and legs as an option. Repeat.

Lie face down on a mat with your arms stretched above your head (like superman)

Raise your right arm and left leg about 5-6 inches off the ground (or as far as you comfortably can).

Hold for 3 seconds and relax. Repeat with the opposite arm and leg.

Lemon Squeezers

Lie flat on your back with legs straight and arms extended above your head. Now, "jack knife" your body by raising your legs straight up, and crunching your stomach until your toes and fingers meet straight above your body. Legs and arms are straight throughout the movement. Imagine that you're squeezing a giant lemon with your body.

Neck nods

Lie flat on your back with legs straight, and hands at your side. Now "nod" your head until your chin touches your upper chest. Return your head to the mat, and repeat continuously. For a harder challenge, nod for 50 reps, and then hold your head in the "up position" and begin turning your head from left to right at a slow but steady rate.

Appendix C

Experimental Group Telephone Script

Hello, my name is ______________________ and I am calling from the UTAS Research Team operating Project PAUSE.

I'm calling about the Exertime activities you completed yesterday.

You have been randomly selected from all participants to complete a verbal check of your Exertime results.

Do you have time to complete this now; it should only take five minutes.

What we are doing is just checking with people to ensure that they have not under or over reported the amount of activity they have reported. There is no penalty if you cannot remember or if your answers are different from what you wrote. This process just allows the researchers to calculate what they call an error measurement.

Would you like to do this now or is there another time in which we can ring you back?

NO. ----- make an appointment

YES.

OK, great.

Yes	No	Question
☐	☐	1. I noticed on your Exertime log that you recorded doing (Exertime activity) yesterday. Is this correct?

Actual	Recorded	
_______	________	How many times did you perform this exercise?
□	□	2. Ok I noticed on your Exertime log that you recorded doing (Exertime activity) yesterday. Is this correct?
Actual	Recorded	
_______	________	How many times did you perform this exercise?
□	□	3. Ok I noticed on your Exertime log that you recorded doing (Exertime activity) yesterday. Is this correct?
Actual	Recorded	
_______	________	How many times did you perform this exercise?

OK, great. Do you have any questions for me? Thank you for your time.

Appendix D

Control Group Telephone Script

Hello, my name is _______________________ and I am calling from the UTAS Research Team operating project PAUSE.

I'm calling to keep you informed about the progress of Exertime.

You have been randomly selected from all participants to complete a verbal check to determine if you have changed any of your physical activity habits over the last couple of weeks.

Do you have time to complete this now; it should only take five minutes.

What we are doing is just checking with people to ensure that they have not changed their exercise or physical activity habits. This process just allows the researchers to monitor what is happening in our waiting group.

Would you like to do this now or is there another time in which we can ring you back?

NO. ----- make an appointment

YES.

Yes	No	Question
☐	☐	**1.** Are you exercising now?
☐	☐	**2.** Do you plan to exercise in the *next* month?

Appendix E

Occupational Physical Activity Questionnaire

READ: This next section is about your physical activity specifically during your paid employment.

1. How many hours per day do you usually work in this job?

[INTERVIEWER NOTE – ASK RESPONDENT TO ROUND HOURS TO THE NEAREST HOUR]

____ __ Hours per day (range: 1-18)

[INTERVIEWER NOTE – IF RESPONDENT WORK HOURS VARY FROM ONE DAY TO THE NEXT, ASK THEM TO AVERAGE THE HOURS PER DAY FOR THEIR PRIMARY JOB OR THE ONE THEY WORK IN THE MOST HOURS PER DAY]

READ: Please recall the hours in a usual day that you spend doing different tasks while at work. If you work more than one job, answer the questions for your primary job.

2. How many hours per day do you sit or stand while at work?

[INTERVIEWER NOTE – ASK RESPONDENT TO ROUND HOURS TO THE NEAREST HOUR]

_____ __ Hours per day (Range: 0- 18)

3. In a usual day, do you do any walking at work, such as walking in the halls, POSal carrier, waiter, or roving sales person?

1 Yes
2 No

4. Considering all walking, how many hours per day do you walk at work?

[INTERVIEWER NOTE – ASK RESPONDENT TO ROUND HOURS TO THE NEAREST HOUR]

_______ Hours per day (Range: 0–18)

5. In a usual day, do you do any heavy labor or use power tools at work, such as moving furniture, carpentry, jackhammers, or using a shovel or pick?

1	Yes
2	No

6. How many hours per day do you do heavy labor at work?

[INTERVIEWER NOTE – ASK RESPONDENT TO ROUND HOURS TO THE NEAREST HOUR]

_______Hours per day (Range: 0–18)

Appendix F

SF–36 Questionnaire

SF-36 QUESTIONNAIRE

Name:____________________ **Ref. Dr:**____________________ **Date:** _______

ID#: _______________ **Age:** _______ **Gender: M / F**

Please answer the 36 questions of the **Health Survey** completely, honestly, and without interruptions.

GENERAL HEALTH:

In general, would you say your health is:

○ Excellent ○ Very Good ○ Good ○ Fair ○ Poor

Compared to one year ago, how would you rate your health in general now?

○ Much better now than one year ago
○ Somewhat better now than one year ago
○ About the same
○ Somewhat worse now than one year ago
○ Much worse than one year ago

LIMITATIONS OF ACTIVITIES:

The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports.

○ Yes, Limited a lot ○ Yes, Limited a Little ○ No, Not Limited at all

Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf

○ Yes, Limited a Lot ○ Yes, Limited a Little ○ No, Not Limited at all

Lifting or carrying groceries

○ Yes, Limited a Lot ○ Yes, Limited a Little ○ No, Not Limited at all

Climbing several flights of stairs

○ Yes, Limited a Lot ○ Yes, Limited a Little ○ No, Not Limited at all

Climbing one flight of stairs

○ Yes, Limited a Lot ○ Yes, Limited a Little ○ No, Not Limited at all

Bending, kneeling, or stooping

○ Yes, Limited a Lot ○ Yes, Limited a Little ○ No, Not Limited at all

Walking more than a mile

○ Yes, Limited a Lot ○ Yes, Limited a Little ○ No, Not Limited at all

Walking several blocks

○ Yes, Limited a Lot ○ Yes, Limited a Little ○ No, Not Limited at all

Walking one block

○ Yes, Limited a Lot ○ Yes, Limited a Little ○ No, Not Limited at all

Bathing or dressing yourself
◯Yes, Limited a Lot ◯Yes, Limited a Little ◯No, Not Limited at all

PHYSICAL HEALTH PROBLEMS:
During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

Cut down the amount of time you spent on work or other activities
◯Yes ◯No

Accomplished less than you would like
◯Yes ◯No

Were limited in the kind of work or other activities
◯Yes ◯No

Had difficulty performing the work or other activities (for example, it took extra effort)
◯Yes ◯No

EMOTIONAL HEALTH PROBLEMS:
During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

Cut down the amount of time you spent on work or other activities
◯Yes ◯No

Accomplished less than you would like
◯Yes ◯No

Didn't do work or other activities as carefully as usual
◯Yes ◯No

SOCIAL ACTIVITIES:
Emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?

◯Not at all ◯Slightly ◯Moderately ◯Severe ◯Very Severe

PAIN:
How much bodily pain have you had during the past 4 weeks?

◯None ◯Very Mild ◯Mild ◯Moderate ◯Severe ◯Very Severe

During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?

◯Not at all ◯A little bit ◯Moderately ◯Quite a bit ◯Extremely

ENERGY AND EMOTIONS:
These questions are about how you feel and how things have been with you during the last 4 weeks. For each question, please give the answer that comes closest to the way you have been feeling.

Did you feel full of pep?
- All of the time
- Most of the time
- A good Bit of the Time
- Some of the time
- A little bit of the time
- None of the Time

Have you been a very nervous person?
- All of the time
- Most of the time
- A good Bit of the Time
- Some of the time
- A little bit of the time
- None of the Time

Have you felt so down in the dumps that nothing could cheer you up?
- All of the time
- Most of the time
- A good Bit of the Time
- Some of the time
- A little bit of the time
- None of the Time

Have you felt calm and peaceful?
- All of the time
- Most of the time
- A good Bit of the Time
- Some of the time
- A little bit of the time
- None of the Time

Did you have a lot of energy?
- All of the time
- Most of the time
- A good Bit of the Time
- Some of the time
- A little bit of the time
- None of the Time

Have you felt downhearted and blue?
- All of the time
- Most of the time
- A good Bit of the Time
- Some of the time
- A little bit of the time
- None of the Time

Did you feel worn out?
- All of the time
- Most of the time
- A good Bit of the Time
- Some of the time
- A little bit of the time
- None of the Time

Have you been a happy person?
- All of the time
- Most of the time
- A good Bit of the Time
- Some of the time
- A little bit of the time
- None of the Time

Did you feel tired?
- All of the time
- Most of the time
- A good Bit of the Time
- Some of the time
- A little bit of the time
- None of the Time

SOCIAL ACTIVITIES:
During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives, etc.)?

- All of the time
- Most of the time
- Some of the time
- A little bit of the time
- None of the Time

GENERAL HEALTH:
How true or false is each of the following statements for you?

I seem to get sick a little easier than other people
Definitely true   Mostly true   Don't know   Mostly false   Definitely false

I am as healthy as anybody I know
Definitely true   Mostly true   Don't know   Mostly false   Definitely false

I expect my health to get worse
Definitely true   Mostly true   Don't know   Mostly false   Definitely false

My health is excellent
Definitely true   Mostly true   Don't know   Mostly false   Definitely false

Appendix G

Semi-Structured Interview Schedule

1. Do you believe that this intervention has assisted with your ability to deal with stress at the workplace? If yes, how?

2. Do you believe that this intervention has prompted you to become more active at the workplace? Why or why not?

3. Do you believe that you have become more productive or less productive with your work duties since you have been a part of this intervention study?

4. Do you believe that this intervention provides a good break and increases your energy levels? Why or why not?

5. Has being a part of this intervention encouraged you to make any changes to your behaviour at the workplace? If yes, what sort of changes?

6. Do you believe that this intervention has contributed to any lifestyle changes outside of the workplace? Please provide any examples.

7. What do you believe are the advantages of being a part of this intervention study?

8. What do you believe are the disadvantages of being a part of this intervention study?

9. Would it feel strange coming to work and not being exposed to this intervention?

10. Would it be worthwhile having this intervention at your workplace permanently?

11. Any other comments or feedback regarding this intervention?

Thank you for your responses to these questions and for being part of this study.

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